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CONTENTS.

THE DISCIPLINE AND EDUCATION OF RAILWAY EMPLOYEES.

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An appeal to a man's better nature, to his self-respect, to his personal interests, to his loyalty to the interests of the company he serves—to make a practical application of the Golden Rule that would regulate the conduct of more than a million men—these constitute the spirit of the system of maintaining the discipline of railway employees known as "Discipline by Record and Without Suspension." This has in the last few years been adopted on fifty-three American railways, constituting over a third of the railway mileage in North America, and displaced the old system of maintaining discipline by suspending employees from service for considerable lengths of time, consigning them to enforced idleness and depriving them of the opportunity to earn the usual means for the support of themselves or families.

It must always be a source of great gratification to railway men that this appeal has been most satisfactorily responded to by the employees on every road and in every condition of service where it was inaugurated, equally so on large and small roads, and in the higher and lower grades of service.

Fear was entertained by many officers that the men subjected to the operations of the new and more humane system would consider the simple entry of an adverse record against them in a book as a very light matter compared with the severe and immediate punishment of a suspension, to which they were accustomed.

These fears proved groundless, and in every case it was quickly demonstrated that the employees were alive to the gravity of a standing adverse record against them, and they invariably tried harder to avoid such records than they had previously tried to avoid suspension. Each man realizing the fact that his daily service was making his record, good or bad, felt a greater responsibility in the proper performance of his duties, and in the performance of the duties of others who might by carelessness involve him in difficulty or subject him to censure. The result was an immediate and considerable improvement in the general efficiency and safety of the train service, resulting on many roads in a noticeable annual decrease of 25 or more per cent. in the cost of accidents, and a larger comparative decrease in acts of negligence. A general superintendent reports that one effect of the record system is to rapidly weed out the incompetent and degenerates of all kinds, and it tends to retain the superior and thrifty men, who will be careful of their own lives and the lives and property entrusted to their care.

As a sequence of the employees who work under this system striving to make good records, it is noticed that the number of annual dismissals is reduced, on some roads to the extent of 34 per cent.; and that the frequency of the necessity of administering discipline is likewise greatly reduced. This all speaks for a more confident, contented and efficient working force, which on any road of considerable traffic must accomplish substantial economies in the costs of operation to keep pace with low rates and competition, if for no other purpose.

The record of an employee should not be a one-sided affair; the giving of judicious credits for specially meritorious service, and for long terms of perfectly satisfactory service, which shall balance possible demerit entries, is only just and wisely prudent. It is a commendable policy that encourages the building up of a good record, and encourages the attentive and careful performance of the daily duties which in the aggregate make large economies or large wastes.

It has come to be generally understood that the underlying principle of the system of discipline by record and bulletin is education—the kind of education that turns the occasional experience of individual employees to good account for the improvement of the whole service, by making such experiences object lessons for the proper and effective instruction of all employees, as well as those directly concerned. Thus, if any employee fails in some duty, and delay to traffic, damage to property or other loss to the company results, directly or indirectly, publication of the facts by bulletin serves to instruct all other employees on the road of the consequence of such failure, and effectively cautions them against similar lapses.

Used in this manner the bulletin board has proved to be a very valuable educator. Its lessons are simple and directly to the point, and partake of the impressiveness of generally costly and sometimes disastrous experience. In the course of the natural evolution of the education of railway employees it is quite probable that the bulletin board will become an auxiliary instead of a chief factor in the work. It is better to teach how not to err than to teach the consequences of erring. But when errors occur, even with the best system of instruction, their lessons must be pointed out, learned and heeded by all concerned. In no other kind of employment embracing large numbers of men does intelligence and education count for so much as in the railway service, and in no other kind of employment can the employees inflict greater losses to the interests they serve than a lack of intelligence and a thorough knowledge of their respective duties.

Large economical advantages will result when all railway managements arrive at a realizing sense of the great extent to which their employees affect the costs of operation, by the intelligence or ignorance and the carefulness or carelessness with which they perform their duties, while keeping within the letter of the rules.

Through the courtesy of the Secretary of the Interstate Commerce Commission I have been favored with advance data from the forthcoming report of the Commission for 1897, and am therefore able to submit statistics of railway operating expenses for the year ending June 30, 1897, herewith first published. These statistics show that approximately the sum of $108,000,000 is annually expended for maintenance of track on the railways in the United States:

Cost of Maintenance of Track on Railways in the United States, 1897.

Repairs of roadway	$73,711,471
Renewals of rails	10,703,304
Renewals of ties	23,245,161
Total	$107,659,936

Education, stimulated by awards of premiums, has proved capable of effecting large savings in this work. Proper instruction in the best and most economical methods of track maintenance, the proper use and care of tools, the preservation of materials, etc., can save railway companies a considerable percentage of the present outlay for maintenance of track, besides assuring greater safety to trains and reduced cost of repairs to the rolling equipment. In recent years intelligently directed efforts to economize in locomotive supplies have achieved, mostly through reduced consumption of coal, such gratifying results as annual savings of $112,000 on one road, $250,000 on another, and $300,000 on another.

These sums indicate the value to railway companies of the proper instruction of engineers and firemen. It has been proven that an engineer can on an average easily save or waste a ton or a ton and a half of coal a day in the operation of his engine. Firemen can also save or waste large quantities of coal. It would be greatly to the benefit of railway interests if all locomotive men could be thoroughly educated in the scientific principles underlying their work, and be thus brought to practice and to understand the advantages of the best methods. Consider the pitiable conditions attending the operation of a locomotive whereon the fireman, either through his own or his engineer's ignorance and carelessness, unnecessarily shovels into the firebox forty tons of coal a month, uselessly consuming valuable fuel and uselessly performing as much unpaid-for work as he would do in firing his engine five or six 100-mile trips. Many operating and mechanical officers can pick out instances of such work on their own roads, engines in the same service and in equally good condition burning 30 or 40 tons of coal per month more than others.

Such instances are sometimes noticed, and the more extravagant engineer is called to the office and warned that he must reduce the coal consumption of his engine to approximate that of the more economical engines. No inquiry may be made of him or his fireman to learn whether they understand and practiice the best and most economical methods of firing, boiler-feeding and the use of steam; and yet upon such knowledge and practice must depend the quantity of coal their engine burns in hauling trains. Criticism or punishment administered by the wise looking official in charge without explaining how to produce better results is not what such men need. Their malady is ignorance, and its only effective and permanent cure is education. Both engineers and firemen should know, as thoroughly as they do the road they run over, every natural operation performed and influence brought into play during the process of generating heat by the combustion of coal and the conversion of its energy into the useful work of hauling trains through the medium of steam and their locomotives. The cycle of these operations can be clearly comprehended by any youth with sufficient intelligence to justify his employment as a locomotive fireman, and the liberal wages generally paid to engineers (average $1,150 yearly) and firemen (average $644 yearly) surely justify some reasonable requirements concerning intelligence, ability and economy of the most expensive operating supply, locomotive fuel. By the proper care or abuse of boilers, the proper or improper use of lubricating oils and the careless or careful handling of the air brake, locomotive engineers also further and largely affect the costs of operation and of the maintenance of both cars and locomotives.

The statistics before referred to show that the following amounts were expended in 1897 for the mainetnance and operation of locomotives:

Costs of Maintenance and Operation of Locomotives in the United States, 1897.

Fuel for locomotives	$65,044,670
Water supply	4,688,124
Oil, tallow and waste	2,592,534
Other supplies	1,105,061
Repairs and renewals of locomotives	39,214,355
Total	$112,644,744

Each of these large items of expense is capable of being reduced by such education of enginemen as has been outlined. The annual aggregate of such reductions would surely reach far into the millions of dollars.

It is coming to be recognized by some officers that the education of railway employees should to some extent precede employment, and that it should be the self education of the applicant for a position in the railway service. In other words, an applicant for a railway position should be able to satisfy the employing officer of his fitness to assume the duties he desires to perform, by his possession of knowledge of the fundamental principles governing those duties. The present practice on most roads permits a green trainman to begin remunerative employment while practically ignorant of the rules and of nearly every duty he should intelligently perform, trusting that he will study the rules after being employed, and that practical experience and that gained from the older trainmen will teach him the proper performance of his duties. Also green firemen are permitted to enter the cab and be paid for actually burning up the money of the company through their unnecessary consumption of coal consequent on their total ignorance of the fundamental principles of combustion and of proper methods of firing. Considerable knowledge could easily be acquired by applicants for such positions regarding the duties of the same, that would enable them to more intelligently and quickly learn the proper practical performance of their work. After employment, neither the disposition or opportunity is so favorable to study as before.

The more careful education of train service employees is capable of improving their services in many ways, enhancing the safety and facilitating the movement of trains, inducing the more careful handling of cars, preservation of tools and use of supplies; inducing also the more considerate treatment of patrons, and the more intelligent use and care of air brake, heating, ventilating and illuminating appliances.

The same authority before quoted gives the following statistics:

Cost of Maintenance of Cars on Railways in the United States, 1897.

Repairs and renewals of passenger cars	$15,683,740
Repairs and renewals of freight cars	44,155,087
Repairs and renewals of work cars	971,618
Total	$60,810,445

Proper charges for superintendence, repairs and renewals of shop machinery and tools, and other necessary expenses increase this amount to about $70,000,000. Those who are practically familiar with the work of train service employees cannot doubt that a very considerable portion of this large outlay could be saved to railway companies by education that would enable and induce these men to exercise greater care and intelligence in the performance of their duties.

These illustrations are sufficient to show that the better education of railway employees promises substantial economies in the many items of expense that go to make up the costs of railway maintenance and operation. Every legitimate means to this end should receive practical encouragement from all who have the best interests of our railways at heart, and every effort of every employee toward self-education and the improvement of his services should be encouraged and rewarded.

As in the case of discipline by record it is found that the interests of railway companies and their employees are mutually benefited by the improved system, so likewise must it be with the better education of employees that will improve their minds and enhance the value of their services. While the companies which employ them will profit by the savings effected, the employees will grow in intelligence, advance in position and in the esteem of their officers, and surely better the condition of their employment and of their surroundings at home.

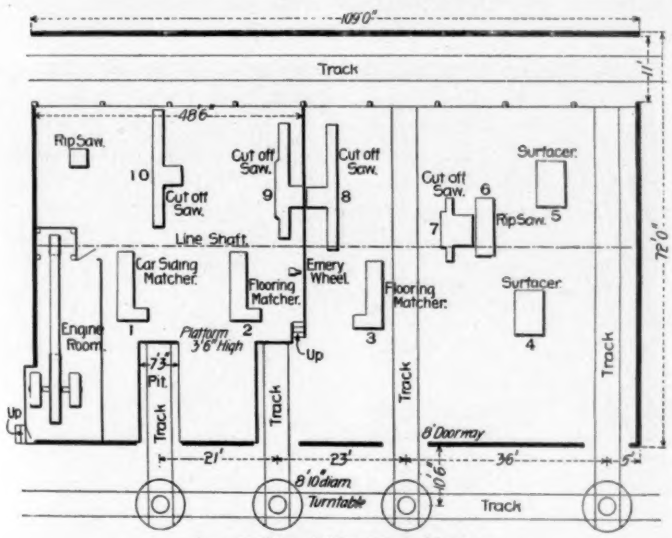
Ordinary steam pumps are proverbially wasteful, but the consumption of 700 pounds of steam per horse-power per hour by two pulsometers at the Lykens breaker, reported by Mr. R. Van A. Norris in a paper recently read before the American Society of Mechanical Engineers, is the highest attainment of which we have record.

BUILDING 15 FREIGHT CARS PER DAY.

Chicago, Milwaukee & St. Paul Railway.

J. N. Barr, Superintendent Motive Power.
J. J. Hennessey, Master Car Builder.

The chief interest in the plant of the car department of the Chicago, Milwaukee & St. Paul Railway at West Milwaukee is that, while originally built for a repair shop, with a rearrangement of the machinery, a very few additions to the machinery and the building of an extension to the erecting shop, it is enabled to turn out 15 box cars of 60,000 lbs. capacity per day. The plan of a portion of the plant devoted to car work is reproduced in one of the engravings, showing the relative locations of the different buildings and the lumber yard. An output of 15 cars for each working day from the middle of January, 1898, until the 6th of June, then 10 each day until Sept. 1, and 15 again from Sept. 1 to Nov. 8, without a break in the record, is a most creditable performance, especially when it is considered that the usual repairs to passenger and freight



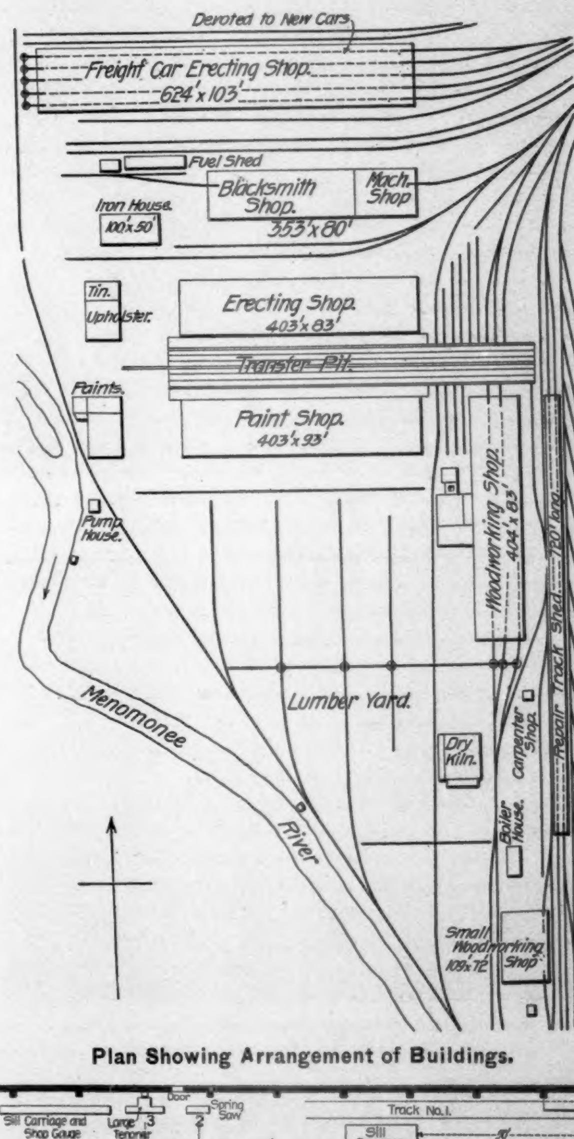
Small Wood Working Shop.

equipment have been carried on at the same time, together with an occasional order for special equipment, such as new cabooses. During the year 1898 3,800 freight cars were built here and placed in service. Of this number 500 were 50-foot carriage cars, illustrated on page 8 of our January issue, and 25 were refrigerator cars 36 feet long. The shops are now turning out 15 box cars per day, in accordance with the plan described below.

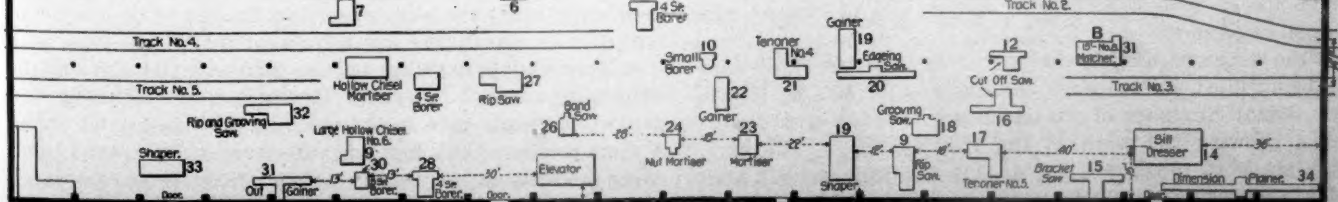
The underlying idea in the entire plan is to make every movement of material count in the construction of the cars, and to that end machinery and facilities have been arranged to avoid all unnecessary handling of material.

The small wood-working shop is used for manufacturing sheathing, flooring, siding and material for roofs and doors. The building is 109 feet by 72 feet. The material is brought in on four transverse tracks for push cars, entering the building from the side toward the lumber yard. Two of them extend entirely across the building, while the others run into recesses in the elevated platform, which is 3 feet 6 inches high, and occupies the left hand half of the building. The light material is handled at this end of the shop, while the heavier stuff goes to the machines at the other end, where the floor is level with the tracks. All material goes across this shop and out at the other side, where it is loaded upon larger push cars, some of which are double-decked and are brought in on the longitudinal track. There are 15 men in this shop, and it is a busy place, where no material is allowed to be piled on the floor.

The large wood-working shop is 404 by 83 feet, with the machinery arranged as shown in the engraving. The idea upon which this mill is operated will be seen by following the course of large timbers, such as sills and plates, through it. These timbers come into the building upon track No. 1 at the upper right hand corner, they pass through the large sill dresser, indicated by "A," and the leading end of the timber is cut off square by saw No. 2, after which that end is tenoned by No. 3. The timber then passes in a direct line to the shop gage, where it stops at the right place to bring the rear end



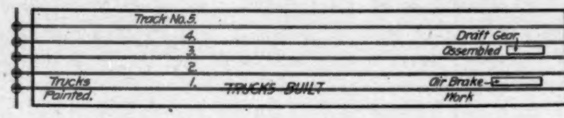
Plan Showing Arrangement of Buildings.



Large Wood Working Shop.

to saw No. 2, where it is squared to the proper length. The tenons on that end are then cut on No. 3 and the timber is ready to be laid out by templets for further work, for which it is skidded to horses near the shop gage. The remaining work is done by the four-spindle boring machine, No. 4, the radial borer No. 6 for angle boring, the hollow chisel mortiser No. 7 and the gaining machine No. 8. The timber is then rolled upon a car on the outgoing track, No. 4, and taken to the erecting shop. The heavy timbers are passed from one machine to the next upon rollers by the machine hands, and no laboring gang is required for this work. The largest part of the product of this shop is in smaller pieces, but they are handled in such a way as to prevent laying them on the floor. The machines are kept busy and the material kept moving. This building handles all the car framing, and while it is an old shop, the machinery was so well placed as to render it necessary to add only three tools in order to increase the output from 10 to 15 cars per day. These machines were a gainer, a hollow chisel mortiser and a five-spindle borer, all of which are Greenlee machines. There is no piecework in any of these shops. There are about 75 men in the large shop, and during the month of September over a million feet of lumber was manufactured in it.

At the time of the visit the last of an order for 1,000 cars was being filled, and through the kindness of Mr. W. H. Elliott, Signal Engineer of the road. we have secured photographs showing the work in the erecting shop. The cars, Fig. 5, are 33 ft. 10 in. long outside, 9 ft. 2 in. wide and 8 ft. high inside; they weigh 30,450 lbs. empty and contain 2,244 cubic feet, the capacity being 60,000 lbs. Mr. J. N. Barr, Superintendent of Motive Power, is responsible for the car department, and Mr. J. J. Hennessey, Master Car Builder, is in direct charge of the work, and the latter has spent a great deal of time in working out the details of the organization and deserves the credit for the system whereby the road can build cars cheaper than they can be bought.



Plan of Freight Car Erecting Shop.

The car erecting shop, with a recent addition, is 624 by 103 feet, and is convenient to the machine and blacksmith shops and to the storage yards, where the finished iron material is piled. The erecting shop has five longitudinal tracks, connected outside at the left hand end by a transverse track and turn tables and at the other end by the yard tracks and switches. The truck work is all done on the first track, and benches at the lower right hand corner of the shop are given to the airbrake work, including the testing. There are generally about 14 or 16 men building trucks, and the rapidity of their work is not the least interesting feature of the car building. Our representative saw a truck of the Barber type, with steel bolsters, put together by two men, complete, except the tightening up of the bolts, in 11 minutes, not including that part of the work done in the machine and blacksmith shops. A short portion of this first track is elevated to facilitate tightening the bolts on the trucks. At the left the trucks are painted and are then ready for distribution. Six men do all the airbrake work. At 7.00 A. M. of the day of the visit the other

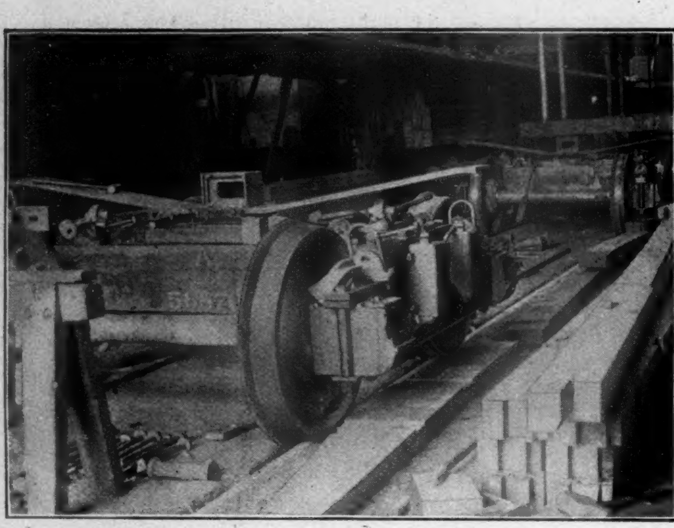


Fig. 1.

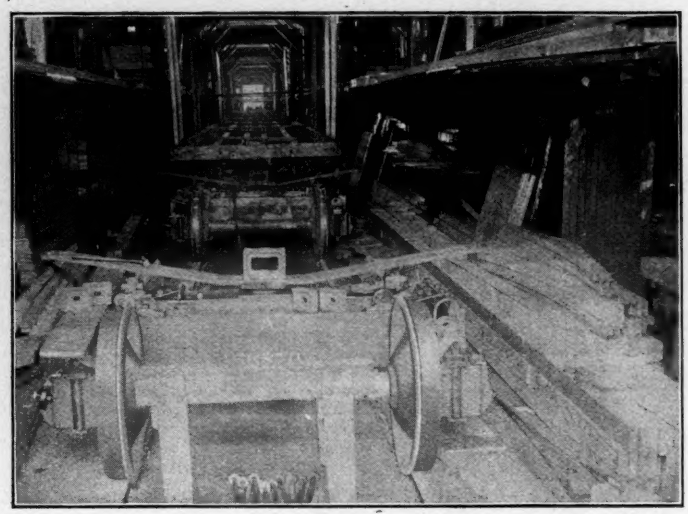


Fig. 2.

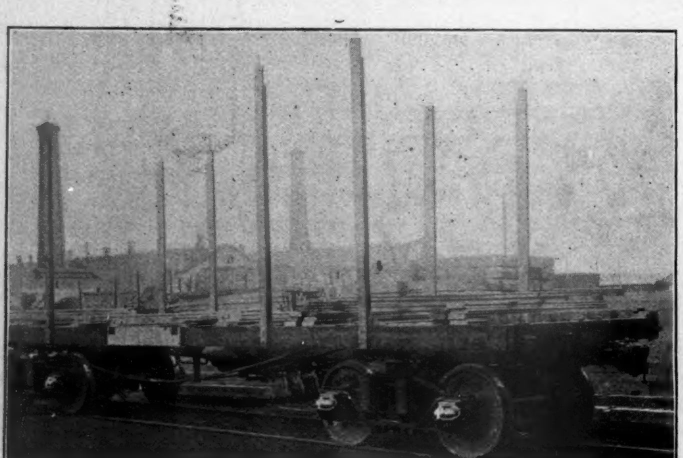


Fig 3.

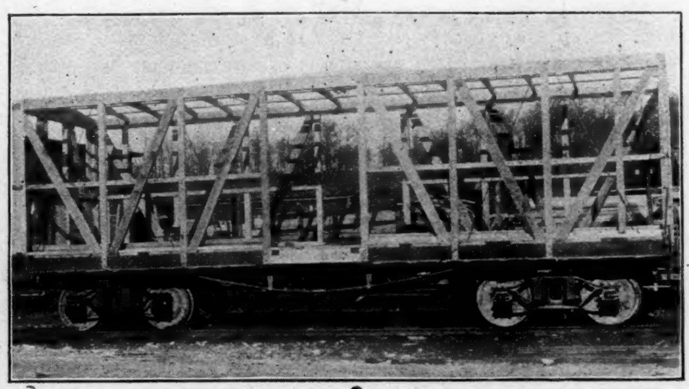


Fig. 4.

tracks in the shop were occupied as follows: Track No. 2 held 15 cars in the condition shown in Fig. 3—that is, ready for the carpenter or car builders. Track No. 3 was filled with trucks and the parts of cars distributed as shown in the foreground of Figs. 1 and 2—that is, ready for the "bottom builders." Track No. 4 held cars that were completed and awaited the stenciling before being pulled out; while on track No. 5 the painters were ready to give the cars the second coat of paint. It will be seen that by using four tracks of sufficient length one of them can be cleared every working day, and the material for 15 more cars is immediately distributed.

There are five gangs of four men each for putting the frames together, and they are called "bottom builders." Figs. 1 and 2 show the material distributed and before they have begun their work. These men usually finish the car body, as shown in Fig. 3, in 2 hours, two working at each end of the car, but on this occasion one of the cars was finished to this point in 65 minutes, including the separation of the trucks, the placing of the bolsters, the draft timbers, couplers, sub-sills, needle beams, the placing of the truss rods, the intermediate sills, the side and end sills, the hanging of the air-brake

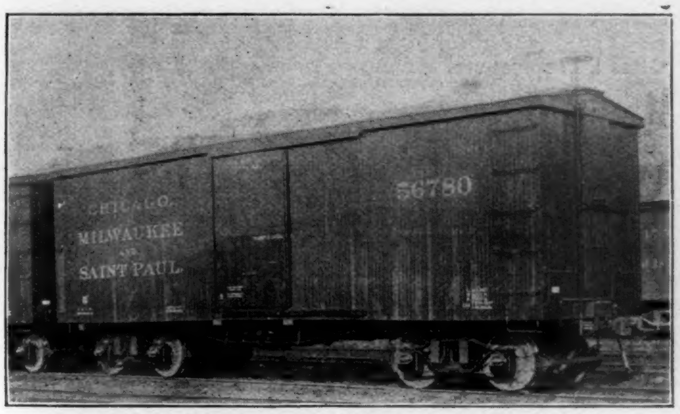


Fig. 5.

cylinder and reservoir and the tightening of the bolts. After the sill work is completed the intermediate posts are put in place. The bottom builders usually complete their construction work before noon and employ the afternoon in putting up brake beams and connecting rods on the cars that have passed the next stage toward completion, after which they distribute material and prepare for the work of the next day. The draft timbers are fitted up by two men, who also distribute the air-brake cylinders and couplers.

The car builders begin with the conditions shown in Fig. 3. There are 15 gangs of five men each, and Fig. 4 represents less than two hours' work, with one gang consisting most of the time of only three men. In the usual course of the work, starting at 7.00 in the morning, the following is the condition after a half hour. The posts, braces, plates, car-lines, purlines and belt rails are in place, with the tension rods tightened, and two men have started on the floor, while the siding has been commenced at the posts and under the doors. This is about the condition indicated by Fig. 4, except as to the siding. When the framing is completed one man begins to nail the roof, while two are laying the floor and one nailing the floor, while the fifth nails the belt rails and puts in the bevel strips. Three men then start the siding, which is finished in about an hour, and as soon as the siding is nailed a painter follows up the carpenter, so that it may be said that the painting and carpenter work is finished at practically the same time. The roofs of the 15 cars, which were the "Chicago," were all on at 2.30 P. M. and were nearly all nailed, the lining was begun at 11.30 and at 3.00 all except the lightest of the work was done, and the cars were fitted with doors and brake beams, the truss rods were tightened and everything left ready for the painters to put on the second coat. Many interesting details of the distribution of the men might be given, but for lack of space they must be omitted.

The painting is done by 12 men, including the stenciling. This latter work requires nine men less than two hours, and the new cars are pulled out of the shop at about 9.00 A. M., leaving that track vacant for the distribution of the material for the next day by the bottom builders. The second coat of paint is put on by six men, who have one track of cars to themselves for the entire day. No pneumatic painting machines and no piecework are used here.

It is evident that to provide all this material required a large amount of planning, which is the more difficult on account of the repair work that must be carried on at the same time. The body and truss bolsters are all made in the shops, and also the brake beams, which are of the Barr patent. This applies also to the wheels, and the only material bought is the iron, lumber, paint and M. C. B. couplers. The operation of the machine and blacksmith shops are worthy of special mention and more attention than we can give them here. In the former multiple drills are used extensively, as well as such short cuts as drilling and countersinking rivet holes at the same time. The transom and bolster channels are all drilled by jigs, with no measuring, and in the blacksmith shop excellent use is made of the bulldozer and bending machines, as well as special machines for fitting up the brake beams.

The cost of building these cars is kept in separate accounts for each department, and the foremen are held responsible for the cost of their respective parts of the work. The thorough organization under Mr. Hennessey appears in the personal interest taken by each foreman in keeping down the cost of the work, which is not less than that of their superiors.

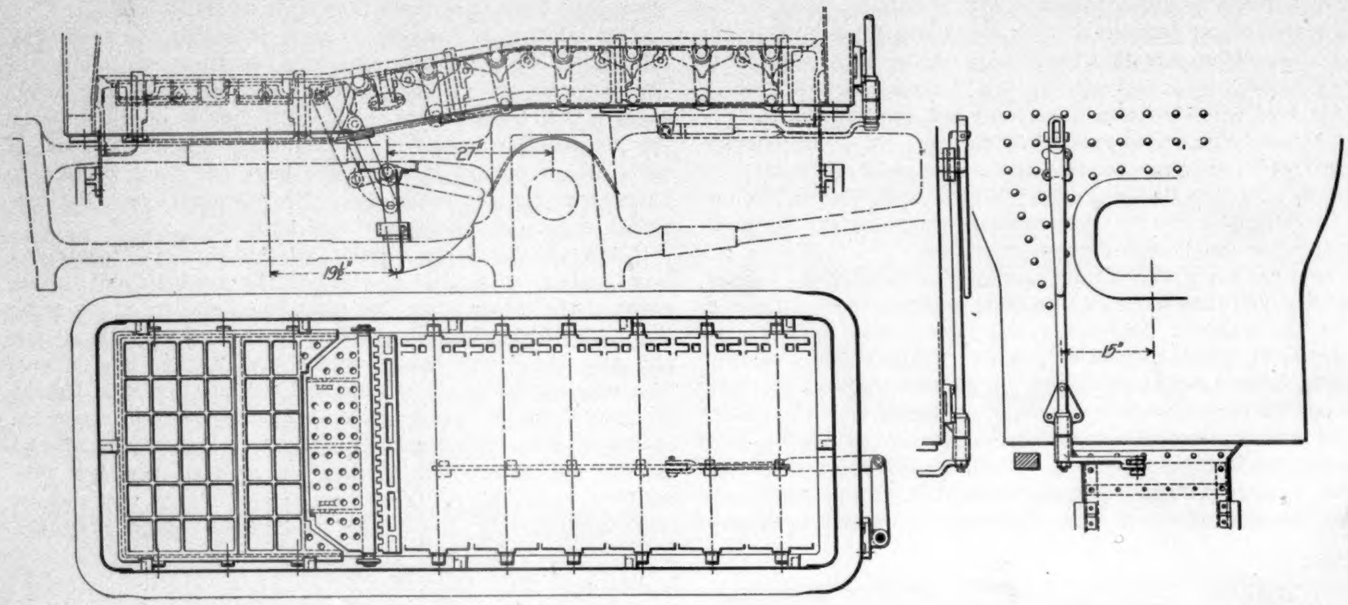
Bright, unskilled laborers are taken for body builders, and they soon become expert. The ambitious ones may become car builders, and there seems to be quite a little emulation among the men. The 15 cars are required to be finished every day. The men understand it and work steadily, as well, in fact, as piece workers. In order to succeed with such a plan it is necessary to know just how much each man ought to do, and the subject is understood in this case. We desire to commend the idea of keeping the machinery and shop facilities in constant use, and that of keeping the more expensive men supplied with material by the cheaper ones.

BICYCLES AS BAGGAGE.

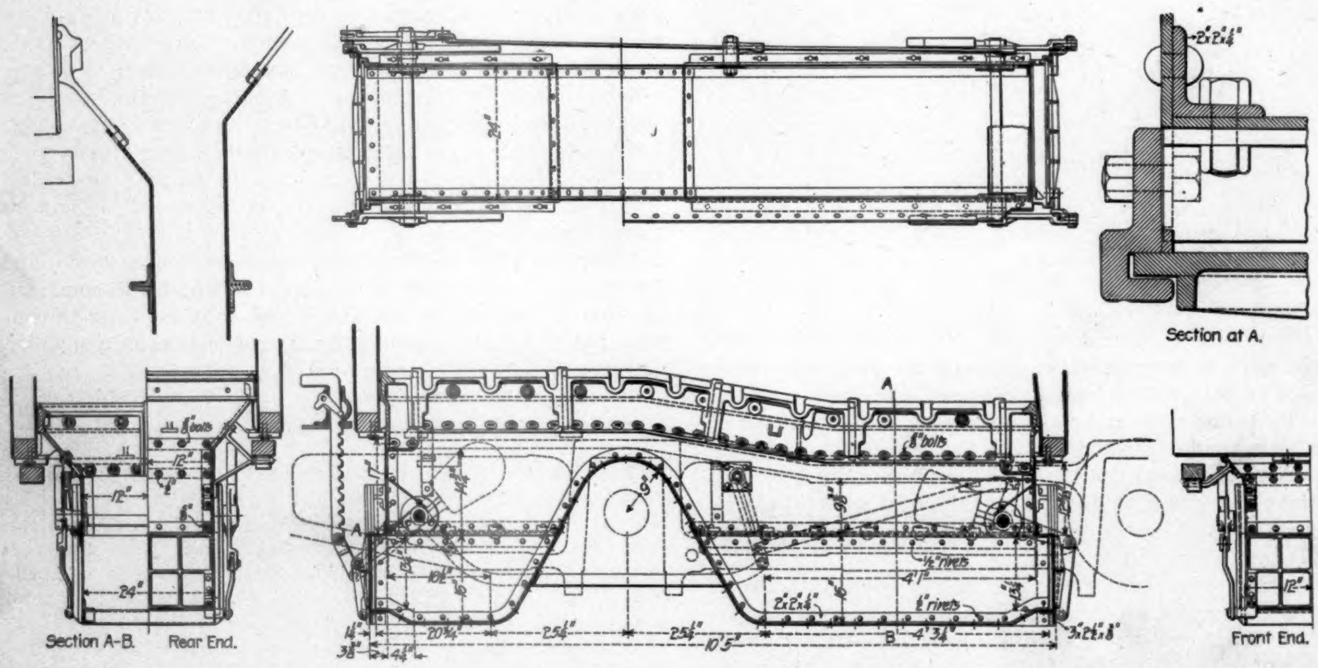
There has been a test case in the English courts on a question which is agitating cyclists all around the world, more or less. It was brought in the Queen's Bench Division against the Great Northern Railway Company "on behalf of one Britten," seeking "to recover sixpence paid for the conveyance of a bicycle from King's Cross to East Finchley." And after hearing and argument the court decided that the plaintiff could not recover for the reason that "a bicycle cannot be ordinary luggage within the definition."

The special interest attaching to this case, says the "Boston Post," is found in the fact that the attorney for the plaintiff made his argument on the very lines on which similar claims are based in this country. He claimed that a bicycle came clearly within the definitiin of "personal luggage" for the reason that it was carrried by the traveler for his own personal convenience and use in connenction with his journey, and was an article such as was ordinarily carrried for that purpose. But his Lordship, in rendering his decision, brushed away all such considerations by declaring that "the idea of luggage" must control; and as luggage implies something that is "packed," not taken "loose, like a bicycle," the wheelman lost his case.

The Keely motor mystery is being somewhat unraveled by searching investigations instituted by the "Philadelphia Press" and conducted at Keely's workshop in Philadelphia by scientific experts. The apparatus belonging to the stockholders had all been removed, but sundry trap doors in the floors of the rooms, pieces of small tubes, at first thought to be wires, and a steel storage sphere, found in the cellar, all point to fluid pressure, probably compressed air, as the source of power. Keely kept his secrets well, and for the benefit of future generations to guard them against repetitions of his scheme, the entire outfit ought to be preserved and placed permanently on exhibition.



Grates for Bituminous Coal.-Class L Locomotives.

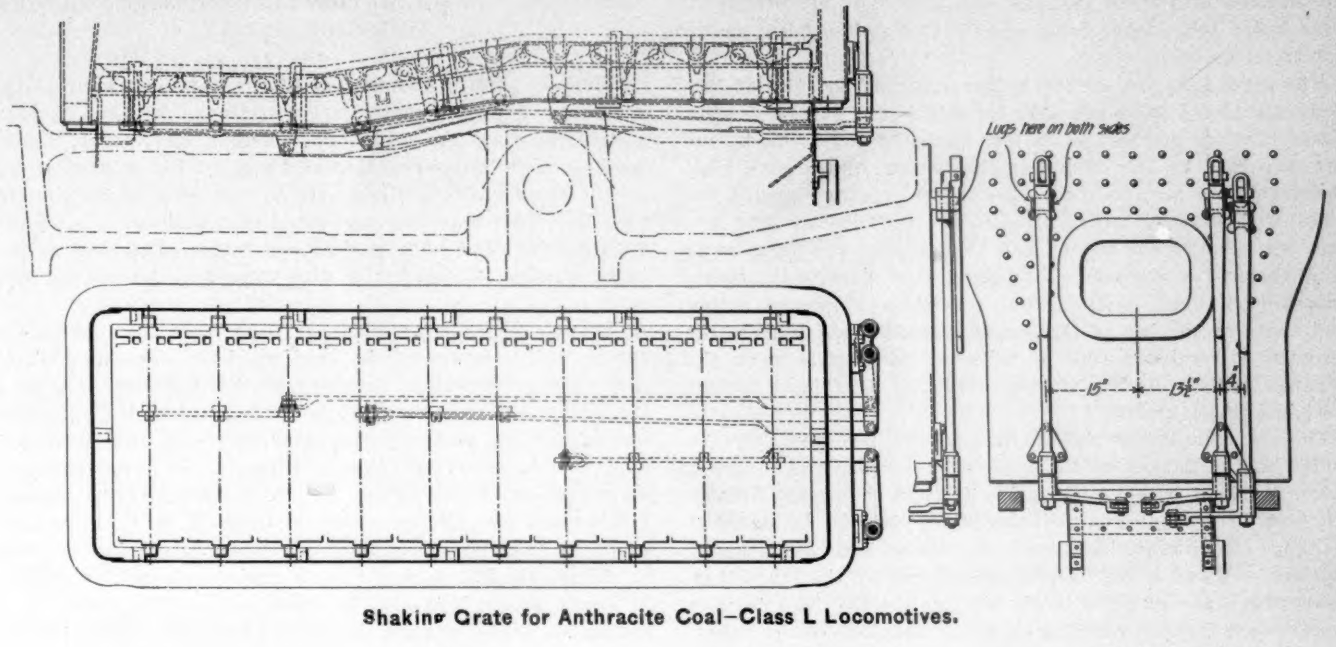


ARRANGEMENT OF GRATES AND ASH PAN FOR BITUMINOUS COAL—PENNSYLVANIA RAILROAD.

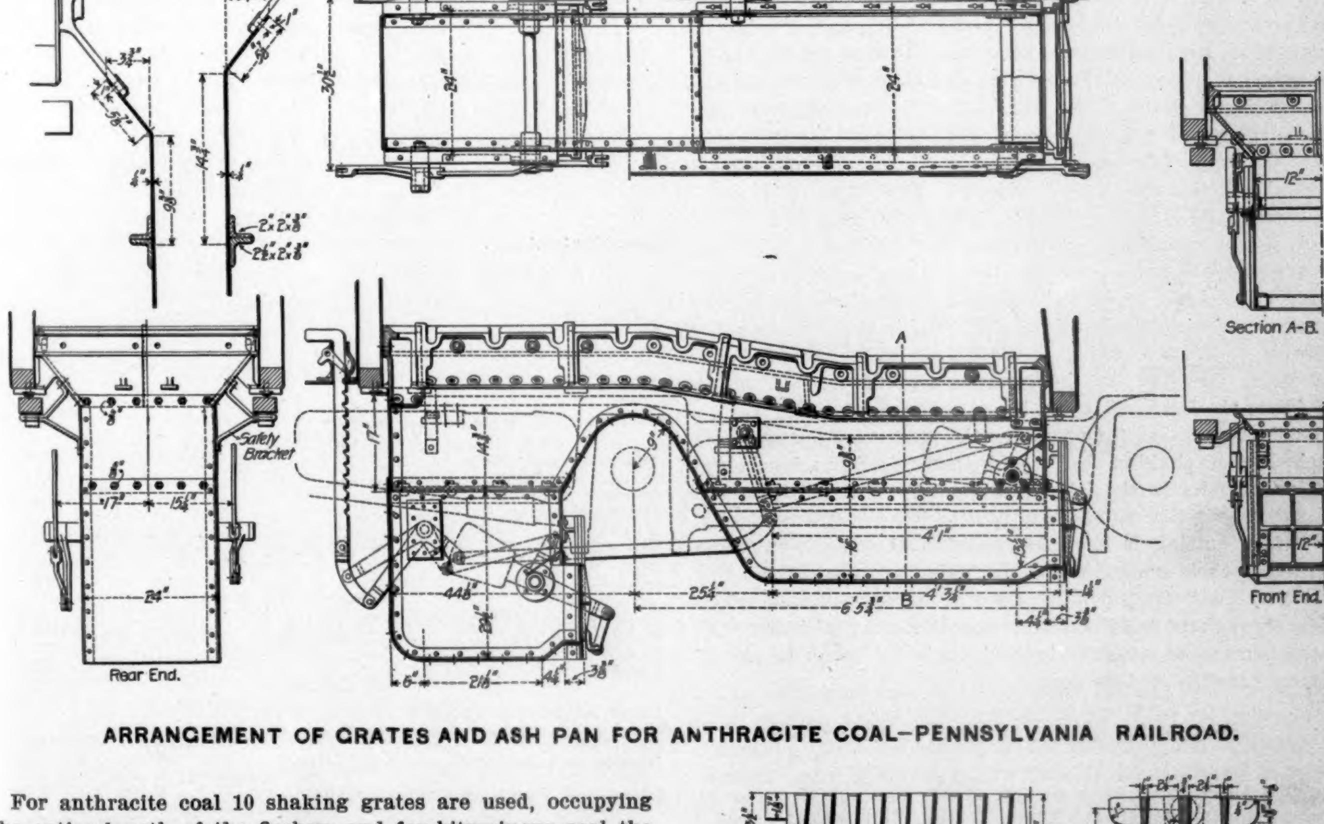
GRATES, ASH PANS AND DAMPERS FOR ANTHRACITE AND BITUMINOUS COAL LOCOMOTIVES.

Pennsylvania Railroad Practice.

In the efforts of many railroad officers to improve in the use of locomotive fuel the very important factor of proper regulation of the admission of air through the grates is neglected, and the design of ash pans and dampers needs more thought than it usually receives. This becomes apparent on examining the usual crude and loose-fitting dampers with their attachments for regulating the amount of air admitted. It is difficult to make a hinged sheet iron damper tight even when new, and it is not easy to obtain a fine adjustment of the area of opening with a device that opens like a hinged door. A sliding cover of substantial and close-fitting construction seems advantageous, and if such dampers are arranged to be easily worked and regulated it seems reasonable to expect that they will be carefully used by enginemen who try to save coal. It is also important to prevent air from getting into the firebox around the edges of the grates, and through the courtesy of the officers of the mechanical department of the Pennsylvania Railroad, we present several engravings showing carefully considered practice as applied to grates on a type of standard locomotives on that road for both anthracite and bituminous coal. The grates, their supports and rocking mechanism, the arrangement of the ash pans and the damper attachments are illustrated. They are those of the "Class L" engines, an extended description of which was printed in our issue of August, 1896, page 166.

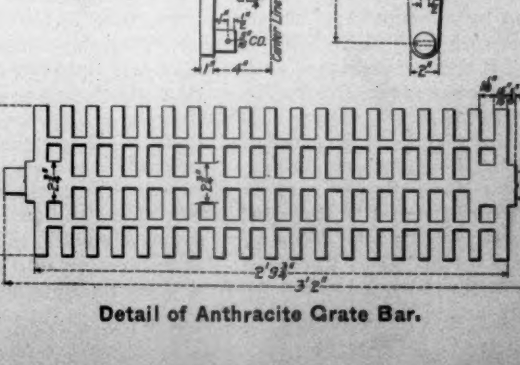


Shaking Grate for Anthracite Coal—Class L Locomotives.



ARRANGEMENT OF GRATES AND ASH PAN FOR ANTHRACITE COAL—PENNSYLVANIA RAILROAD.

For anthracite coal 10 shaking grates are used, occupying the entire length of the firebox, and for bituminous coal the forward end for about 33 inches is taken up by dead plates, back of which is a perforated drop grate 14 inches wide. In some of the later types of engines it has been found necessary to increase the number of shaking grates in order to prevent the coal from being dragged up towards the tube sheet by the draft, but the ash pan and grate-bearer arrangement has not been changed. For bituminous coal the grate fingers are 10 inches long, measured from the end of one of them to the end of the one opposite to it, the bars are ⅞ inch wide and the spaces between them are of the same width as the bars. The grates are sometimes connected and operated together, and sometimes are divided into two sections, depending upon the number of shaking bars used. For anthracite coal the grates



Detail of Anthracite Grate Bar.

are divided into three sections, the fingers of the individual bars being 10⅝ inches long and ¾ inch wide, with spaces 1 1/16 inches wide.

The grate bars are carried by bearing castings, formed into flanges at their bottom edges for the attachment of the ash pans. These castings are held to the side of the firebox by studs, and are also held by lugs bolted to the bottom of the mud ring. Special efforts are made to close up all openings around the sides of the firebox, to exclude cold air from coming into contact with the firebox sheets, and also to keep the flame away from them. The access of air to the firebox close to the sheets causes high local heating, that resembles blow-pipe action and shortens the life of the sheets. These grate bearers are grooved to receive a rope of asbestos packing between the castings and the firebox sheets, making a tight joint around the edges of the grates.

The ash pans are of plate, with angle frames, and they are bolted to the flanges of the grate bearer frame. Additional safety brackets, bolted to the under faces of the engine frames, are used to prevent the ash pan from falling in case of breakage of the grate bar frame, and the weight of the grate, coal and ash pan is not carried exclusively by the studs that secure the grate supports to the firebox sheets. The damper openings are large, permitting of easily cleaning out the ashes.

In this design the dampers slide vertically. They are of cast iron and fit closely in grooves. Their weight is balanced, in order to render them easy of operation. While the arrangement of dampers at the front and rear ends of the ash pan works very well for bituminous coal, it does not give entire satisfaction with anthracite, and the drawing of the latter arrangement shows the dampers in the front of the front half and also in the front of the rear half of the pan, the rear portion being extended downward below the level of the front portion. The same damper rigging and cast iron sliding dampers are used in both cases. This mechanism, while rather elaborate, has been found satisfactory, and it does not get out of order. Its chief feature, aside from tightness when closed, is the ease of adjustment by means of the notched rods extending through the deck of the cab. The rods are held by latches that are encased in the housings which guide the rods, and coal is prevented from clogging the latches. To lower a rod, the man places his foot on the opposite end of the bell crank that forms the latch, releasing it.

The shaking levers for operating the grates are permanently attached to the shaking shafts, and when raised to a horizontal position the slot in the head engages with the crank on the top of the shaft, but when out of use the lever hangs vertically, and before putting it into this position the grates must be returned to their normal position. This is to protect the tips of the grate bars from being burned by careless firemen. The design throughout is substantial, and is worthy of being considered permanent construction, which is too much to say of common practice in this regard.

NEW YORK RAILROAD CLUB.

Mr. Charles Hansel, M. Am. Soc. C. E., General Manager of the combined National and Union Switch and Signal companies, read an able and comprehensive paper on railway signaling at the January meeting of the New York Railroad Club, illustrated by stereopticon. The paper combined technical signal engineering with elementary explanation of the mechanical interlocking and presentation of the principles involved in the use of the electric train staff. The author gave operating men a great deal to think about, particularly in connection with the definitions of the home block and advance block signals established by the American Railway Association, and suggested the use of a distinctive semaphore signal for the block signal where the home signal is also used. This signal has two arms on the same spindle, the front one having a square end and the other a notched end. The paper was suggestive, and copies should be secured by those who have to do with signaling and train operation.

COMPOUND CONSOLIDATION LOCOMOTIVES, NORTHERN PACIFIC RAILWAY.

The Schenectady Locomotive Works have just built 14 two-cylinder compound consolidation engines for the Northern Pacific Railway, the design of which is interesting in comparison with the powerful compounds of the mastodon type by the same builders, illustrated in our issue of March, 1897, page 97. This road has considered the compound locomotive with special care, and its past and future experience with a large number of engines of this type may be studied with profit.

Through the courtesy of Mr. William Forsyth, Superintendent of Motive Power of the road, we have received a photograph and particulars of the new type that is known as Class Y. We understand that the same boiler is used, with 2,923 square feet of heating surface. The total weight of the Class Y is 3,200 pounds more than that of Class X, the mastadons, and the weight on the drivers of Class Y is more by 19,000 pounds. The weight per driving wheel of Class Y is 21,125 pounds, which is 2,375 pounds greater per wheel than that of Class X. These weights render the new design suitable for pushing on heavy grades and also for road work. The cylinders of both types have the same diameter, 23 and 34 inches, but the stroke of Class Y is 34 inches, an increase of 4 inches over Class X, while the driving wheels are of the same diameter in both. We are informed that the new engines are expected to develop a drawbar pull of 40,000 pounds at a speed of 10 miles per hour. The working steam pressure will probably be about 210 pounds per square inch, although the boilers are built to carry 225 pounds. The small diagram of the engine gives the chief dimensions and the photograph shows the engine to be remarkably symmetrical for a large one. The tires of the second and third pairs of driving wheels are plain, the flanges of the forward tires being set ⅜ inch narrow in gauge in order to throw more of the work of guiding the engine upon the truck wheels. It will be noticed that the sand boxes used in backing are hung under the running boards.

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	189,200 lbs.
" on drivers	169,000 lbs.
Wheel base, driving	14 ft. 8 in.
" " rigid	14 ft. 8 in.
" " total	23 ft. 3 in.

Cylinders

Diam. of cylinders	H.P. 23 in. L. P. 34 in.
Stroke of piston	34 in.
Horizontal thickness of piston	4¾ and 5¾ in.
Diam. of piston rod	3¾ in.
Kind " " packing	Cast iron
Size of steam ports	H. P. 18 in. x 1⅝ in. L. P. 23 in. x 2¼ in.
" " exhaust "	H. P. 18 in. x 3 in. L.P. 23 in. x
" " bridges	1⅜ in.

Valves.

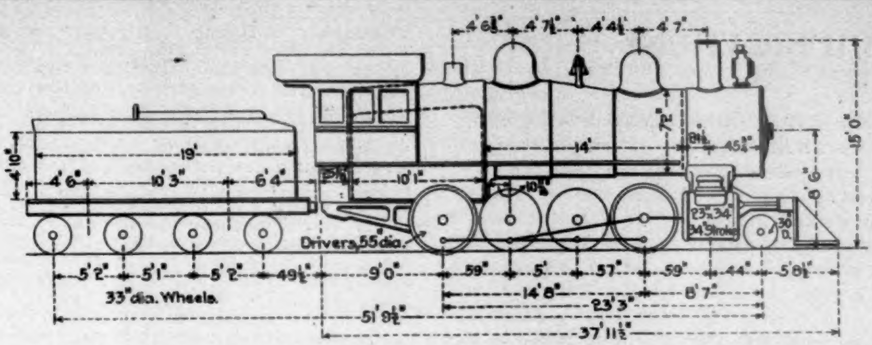
Greatest travel of slide valves	6 in.
Outside lap " " "	H.P. 1¼ in. L.P. 1 in.
Inside " " " "	¼ in.
Lead of valves in full gear	⅛ in. blind

Wheels, Etc.

Diam. of driving wheels outside of tire	55 in.
Metal " " " centers	Cast steel
Tire held by	Shrinkage
Driving box material	Main, cast steel; 1st, 2d and 4th, steeled cast iron.
Diam. and length of driving journals	Main, 9 in. diam. 1st, 2d and 4th, 8½ in. dia. x 10 in.
" " " " side rod crank pin journals	2d, 5½ in. x 5 in.; 1st and 4th, 5 in. dia. x 3¾ in.
" " " " main crank pin journals	Main, side, 7½ in. x 5¼ in.; 6½ in. diam. x 6 in.
Engine truck, kind	2 wheel swing bolster
" " journals	6 in. diam. x 11 in.
Diam. of engine truck wheels	30 in.

Boiler.

Style	Extended wagon top
Outside diam. of first ring	72 in.
Working pressure	225 lbs.
Fire box, length	120 3-16 in.
" " width	42 in.
" " depth	F., 77 in.; B., 73½ in.
" " plates, thickness	sides, 5-16 in.; back, 5-16 in.; crown, ⅜ in.; tube sheet, ½ in.
" " water space	front, 4½ in.; sides 3½ to 4 in.; back, 3½ to 4½ in.
" " crown staying	Radial stays, 1⅛ in.
" " stay bolts	Ulster special iron, 1 in. diam.
Tubes, number of	330
" diam.	14 ft.
" length over tube sheets	144 in

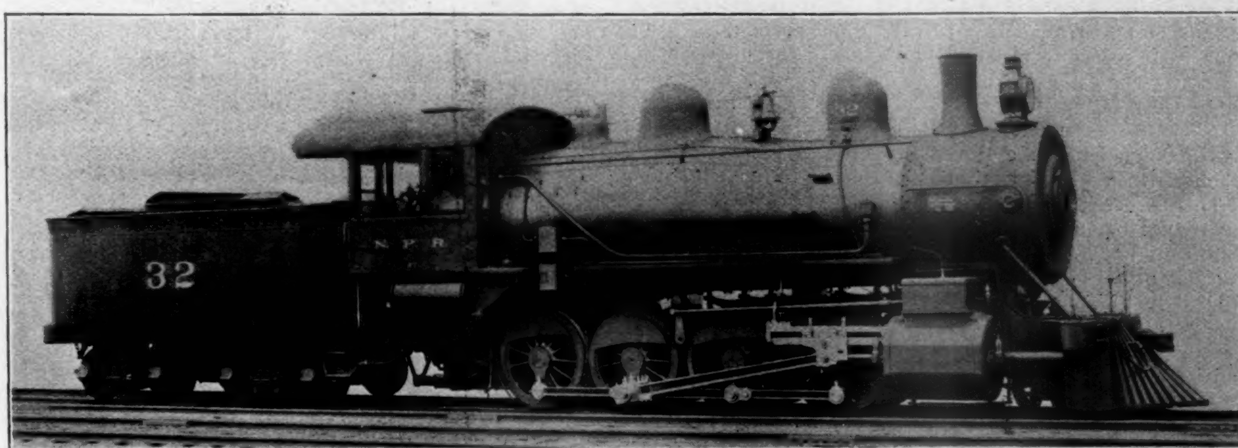


Compound Consolidation Locomotive, Class Y.—Northern Pacific Railway.

Fire brick, supported on	2 water tubes
Heating surface, tubes	2,705.2 sq. ft.
" " arch tubes	15.3 "
" " fire box	202.9 "
" " total	2,923.4 "
Grate surface	35 "
Exhaust, nozzles	5¼ in., 5½ in. and 5¾ in. diam.
Smoke stack, inside diam	18½ in. at top, 16 in. near bottom
" " top above rail	15 ft.

Tender.

Weight, empty	44,850 lbs.
Wheels, number of	8
" diam. of	33 in.
Journals, diam. and length	5 in. diam. x 9 in.
Wheel base	15 ft. 8 in.



Compound Consolidation Locomotive—Northern Pacific Railway.

WILLIAM FORSYTH, *Superintendent Motive Power*. SCHENECTADY LOCOMOTIVE WORKS, *Builder*.

Tender frame	10 in. steel channel
" trucks—Center bearing, double I-beam bolster, with side bearings on back truck.	
Water capacity	5,500 gals.
Coal "	8 tons
Total wheel base of engine and tender	51 ft. 9½ in.

Engine equipped with McIntosh blow-off cock, Detroit cylinder lubricator, American outside equalized brake on all drivers, operated by air; Westinghouse air brake on tender and for train, Magnesia sectional lagging on boiler and cylinders, Gollmar bell ringer and Ashcroft steam gauge.

CHEAPER GAS AND THE FUTURE OF THE GAS ENGINE.

Cheaper gas may be expected to induce a general increase in the use of gas engines, and a movement now on foot in Boston may exert a marked influence in this direction. The "Engineering Record" states that Mr. Henry M. Whitney, President of the Brookline Gas Light Company, who also controls large coal resources in Nova Scotia, has asked the city authorities of Boston for the privilege of supplying coal gas of 18 candle power containing less than 10 per cent. of carbonic oxide, at a rate of 75 cents per thousand cubic feet when used in gas engines for power purposes. The price is to be 1 1-5 cents per horse-power hour in gas engines up to 100 horse-power, 1 1-10 cents in engines from 100 to 200 horse-power, and in engines of more than 200 horse power the cost will be 1 cent per horse-power hour. Mr. Whitney states the present cost of electric power to be from 3½ to 7½ cents per horse-power hour, depending upon the quantity used. The cost of fuel for a steam engine on a basis of 6 pounds of coal per horse-power is the equivalent of 1 1-5 cents per horse-power hour, but this economy cannot be obtained in small engines that are in most common use. Mr. Whitney estimates the average consumption of small engines at about 10 pounds of coal per horse-power hour when actually at work, and the cost of the power at 2 cents for the same unit against 1 1-5 cents for the gas engine. This is considered as the beginning of a movement in the direction of cheap gas that is likely to spread, and if so, its influence on the future of the gas engine will be powerful. At these rates power may be had for manufacturing purposes at an advantage over steam or electricity when produced by steam.

The estimated cost of the electric railway up the Jungfrau is $2,000,000, about one-half of which is to be expended in tunneling. The forecast of traffic receipts give an annual income of about $150,000, at the rate of about $7 per passenger for the round trip to the summit. The line will be about eight miles long, so that the rate per mile will be about 45 cents. Considering the nature of the route, however, says the "Mechanical World," the charge is not excessive. The last 240 feet of the ascent is to be made by a vertical lift. Electric elevators of American make will here convey the passengers to the surface at the very summit of the mountain. The tunnels along the route will be 14 feet in diameter, and will be lighted by electric lamps, supplied by wires with a current separate from that of the railway. Storage batteries will be placed at each station for lighting purposes, and to provide for emergencies. The electric equipment of the entire line will be most complete, and the railway will be the most remarkable piece of railway construction thus far attempted.

COMMUNICATIONS.

POWERFUL PASSENGER LOCOMOTIVES FOR FAST TRAINS.

Editor American Engineer:

I have been much interested in reading your article in the present issue on "Powerful Passenger Locomotives for Fast Trains," proof of which was kindly sent me. I believe that your analysis of the results obtained by Mr. Vauclain and myself is correct.

This matter is, in my opinion, one of much importance to designers of high-speed locomotives, inasmuch as it points to the fact that by giving attention to the details of the valve motion, valves and ports, much more power can be gotten out of the cylinders of our locomotives at high speed than has heretofore been available. The conclusions by Professor Goss a year or two since were that there was a rapid falling off in the power after reaching a speed of from 180 to 200 revolutions per minute, due to the defective distribution of steam, which, in turn, resulted from the wire drawing caused by insufficient port areas and defective valve motion. These conditions were, I believe, true for locomotives built a few years ago, and are perhaps true for a great many engines now running. The later results, obtained with the Vauclain system of compounding, show very clearly what can be done and what is being done to correct these evils by more careful design and construction of valve motion, and better arrangement of valves and ports.

All this is, it seems to me, quite apart from the question of boiler power. The failure of our locomotives at high speed has generally been a failure to get sufficient work out of the cylinders. If, as has been shown, it is possible to obtain more power with a given size of cylinder, then it is necessary to furnish a boiler which will supply sufficient steam to meet the demand. This is, perhaps, the simpler end of the problem.

To guard against a possible misapprehension of the results set forth in my paper, I desire to call attention to the fact that the diagram, Fig. 1, which apparently shows the power curve to be a straight line passing through the origin, is, though correct, likely to be misinterpreted. It will be noticed that the scales of the ordinates and abscissæ do not begin at zero. If the diagram be continued to include the origin, it will be seen that the power curves do not pass through the latter, but above it. The diagram shows, then, that the increase of power with speed is at a constant ratio, but that this ratio is less than 1.

Yours very truly,
R. A. SMART,
Associate Professor of Experimental Engineering.
Purdue University, January 18, 1899.

CAST IRON IN RAILWAY PRACTICE.

Editor "American Engineer":

The interesting paper in your current issue on "Cast Iron in Railway Practice," referring to the remarkable effect of adding ferro-manganese to car wheel iron in the ladle, recalls to my recollection an extended investigation made 15 years ago upon this subject. I inclose herewith, thinking it may be interesting, the first record in print of these experiments contained in an abstract of a lecture given at the Franklin Institute in March, 1888:

Manganese is commonly supposed to exert a hardening tendency upon pig iron, but experience has taught me to regard this is as another mistaken notion, it undoubtedly produces a marked effect upon the character of the white crystalline structure. You may readily recognize "a manganese chill" by its coarse lamellar or foliated filaments and by the tendency which it produces to form white iron or "hard spots" in isolated places throughout the gray portion of a casting. Manganiferous pig iron has been used to produce chilled castings, but it does not make a durable wearing surface; the chilled tread of a car wheel, for example, produced by this method, presents to the eye, when broken through the section, a handsome appearance, but the white metal is comparatively soft; it may be easily bored, and, what is more serious, it crumbles readily under the impact of rapid shocks on the rail.

A remarkable effect is produced upon the character of hard iron by adding to the molten metal, a moment before pouring it into a mold, a very small quantity of powdered ferro-manganese, say 1 lb. of ferro-manganese in 600 lbs. of iron, and thoroughly diffusing it through the molten mass by stirring with an iron rod. The result of several hundred carefully conducted experiments which I have made enables me to say that the transverse strength of the metal is increased from 30 to 40 per cent., the shrinkage is decreased from 20 to 30 per cent. and the depth of the chill is decreased about 25 per cent., while nearly one-half of the combined carbon is changed into free carbon; the percentage of manganese in the iron is not sensibly increased by this dose, the small proportion of manganese which was added being found in the form of oxide in the scoria. The philosophical explanation of this extraordinary effect is, in my opinion, to be found in the fact that the ferro-manganese acts simply as a deoxidizing agent, the manganese seizing any oxygen which has combined with the iron, forming manganic-oxide, which, being lighter than the molten metal, rises to the surface and floats off with the scoria. When a casting which has been artificially softened by this novel treatment is re-melted, the effect of the ferro-manganese disappears and hard iron results as a consequence.

The late Wm. Wilmington brought some powdered ferro-manganese to the late Geo. Whitney, of Philadelphia, about 1883, and requested permission "to pour a handful into the head box of a car wheel mold, when the mold was partly filled." This he did, and the wheel was broken up for examination. The effect of the ferro-manganese on the gray metal of the plate was plainly visible as far as it penetrated, and the matter was placed in my hands for investigation and report.

Mr. Wilmington, unfortunately, did not understand the rationale of his process at all, and, I believe, failed to reap any advantage from his original discovery; he patented a process —as noted in the lecture—which was never practiced, and the modification of adding ferro-manganese in the ladle, proposed and adopted by me, was strenuously opposed by him. Gradually knowledge of the process spread abroad, and in time it came into almost universal use in car wheel establishments.

Showing "Too High Chilling."

The table on page 8 of your magazine, giving "tests of wheel iron with ferro-manganese," shows that a little over one-half of the combined carbon is changed into graphitic carbon by the use of the largest percentage of ferro-manganese (see No. 6). This agrees pretty well with the results published in 1888, using a smaller percentage of ferro-manganese, viz.: "Nearly one-half of the combined carbon is changed into free carbon."

The half-tone illustration shows a section of a car wheel made from a re-melt of old wheels, in which the metal was entirely too high-chilling, and even mottled, until softened by the addition of about 1 lb. of ferro-manganese in a ladle holding about 600 lbs. of iron.

A. E. OUTERBRIDGE, JR.
Philadelphia, January 4, 1899.

THE M. C. B. COUPLER ABROAD.

Editor American Engineer.

While our master car builders are wrestling with the problem of strengthening and standardizing the vertical plane coupler, it may be in order to review the situation abroad and see what our fellow craftsmen in foreign lands are doing in regard to the car coupler question. As is well known, American freight cars are of so much greater capacity than those of other countries that the phase of the problem at present confronting us is of no immediate concern to our friends abroad, with their 10 to 20 ton equipment, but sooner or later they will profit by the experience we have so dearly bought, and it is safe to predict that when the automatic car coupler makes its appearance on the monthly shop requisitions of Eu-

ropean railroads it will be the latest and most improved type of the M. C. B. coupler. That the time is not far off present indications show.

Our consuls abroad take care to report that American cheese does not sell as well in England as the Canadian, and that American linseed oil is making good headway in France, and that last year's apple crop in Germany fell below the average. The bicycle market is given its share of consular attention, and American tool and machine makers receive an occasional hint. But the railway supply trade, which has grown to such vast proportions in this country, is seldom touched upon in these reports, because the consuls are not railroad men and do not come in contact with railroad men as they do with merchants and commercial men, and it is not to be expected that they can give intelligent information about matters with which they are unfamiliar. The large manufacturers of railroad supplies having their own representatives abroad, permanently located or on periodical trips, are able to take care of their own interests, but those who have not yet developed a foreign trade are at a great disadvantage in any attempt to do so without reliable advice how and where to meet the wants of the railroads abroad. The principal source of information in that line for our manufacturers of railroad supplies in general is the English press, the English engineering and trade journals, in occasional reports and notes dealing with the needs of the railroads of their own country. It is a conspicuous fact, however, that the English railroads are the most conservative on earth, and these press reports do not therefore always reflect the true situation on the Continent.

A short time ago the papers reported that on account of the alarming number of injuries to employees on the English railroads, as compared with American, legislative action would probably be taken for the purpose of compelling the use of automatic couplers, but adding that the railroads were expected to enter a vigorous protest because of the cost. In Germany, however, the subject is considered from another point of view. The question there is not whether automatic couplers shall be introduced, but when and how. The German railroad officials have been watching our M. C. B. coupler committees as eagerly as the coupler manufacturers have been watching each other. The European type of car coupling at present in use would not materially interfere with the application of automatic couplers, where a suitable draft rigging for the latter can be applied below the present draft gear, which would remain undisturbed in order to connect with cars equipped for its use only.

In Sweden the Government is preparing to build a number of refrigerator cars, for the purpose of meeting the altered demands of the kingdom's large beef export trade. Until recently cattle have been shipped to England alive, but on account of a hoof disease prevailing in Europe this is now prohibited; hence the need of refrigerator cars to retain their trade. These cars will probably be as large as the American, and the understanding is that they will be equipped with automatic couplers in order to facilitate a rapid handling of the cars.

In Italy the freight cars are of the American type to a large extent, and the vertical plane couplers could be applied to them without difficulty, but as the railroads there do not pay expenses, there is no money in sight to spend for improvements.

Progressive little Japan has taken still one step nearer. More than one coupler manufacturer in this country has received blue prints of its freight cars, with request to submit figures for the cost of his coupler and a draft rigging for the same, suitable for the construction of these cars.

Such signs of the times indicate that before long the automatic coupler will be an established fact in every country where railroading is carried on to any extent. In the light of the experience here, it is not probable that any but vertical plane couplers of the M. C. B. type will be considered abroad, and as almost every possible variation of this class has been conceived and tried in this country it is scarcely possible that any new forms can be brought out.

Few, if any, of the M. C. B. couplers are patented, and in most cases the time set for applying for such patents has expired. The coupler manufacturer who desires to market his product in foreign countries may, therefore, have to go into open competition with native enterprises. It is not to be hoped that the railroads abroad are willing or able to pay higher prices, commensurate with the freight and import duties, than our own railroads can afford, so that the manufacturer would either have to be satisfied with less profit or establish foreign branch factories to supply this trade, as the Westinghouse Air Brake Company and some other firms have done for their specialties.

The Paris Exposition next year will provide our coupler manufacturers with the needed opportunity at the right time to feel their way for prospective European trade, but it is unnecessary to say that only those that are thoroughly protected by European patents, or that in lieu of such protection can command sufficient capital to fight competition, need to enter the field with hope of financial returns.

EDW. GRAFSTROM.

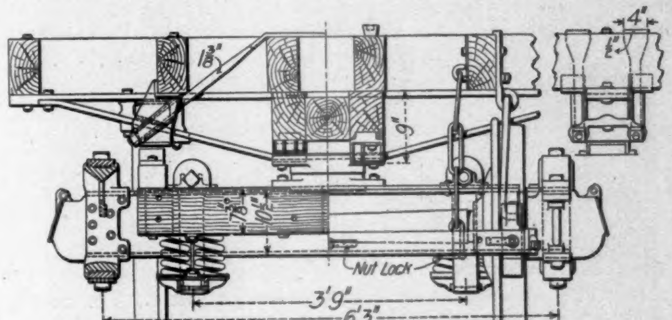
Columbus, Ohio, January 19, 1899.

TRUSSED BODY BOLSTER AND SPRING STIRRUPS FOR FREIGHT CARS.

C. & N. W. Ry.

The accompanying engraving illustrates an arrangement of body bolsters and truck bolster spring supports devised by Mr. C. A. Schroyer, Superintendent of the Car Department, Chicago & Northwestern Railway, and used in construction of standard cars of various capacities. The object of the trussed body bolster is primarily to secure additional strength without adding materially to the weight, and at the same time to preserve dimensions that are in general use on the cars of the road.

The body bolster is reinforced by two truss rods having a rectangular section ½ by 4 inches at the center where they pass over the center sills, the bodies being round, 1⅜ inches in diameter, and passing through malleable iron castings, which also form the body side bearings. These castings also form a seat for the nuts at the ends of the truss rods. They



Trussed Body Bolster and Spring Stirrups.
C. & N. W. Ry.
MR. C. A. SCHROYER, *Supt. Car Department.*

were designed with a view of resisting the pull on the truss rods and the side bearing castings are of very substantial construction, having a flange at each side which abuts against the outer face of the intermediate sill to take the thrust from the rods, a part of which is also resisted by shearing action on the side bearing bolts. The form of the side bearing is such that it may be slipped in place without interfering with the construction of the bolster, and it adds very little to the cost. It is said that the outer ends of the bolster may be easily raised by tightening the nuts on these rods. Mr. Schroyer is to be congratulated on his easy and cheap solution of the limber bolster question, with its attendant problem of keeping side bearings apart. This trussing ought to have wide application in stiffening weak bolsters, even beyond the capacity for which they were made and under which they may have failed. It certainly may be made the means of saving light bolsters now running, to an extended period of usefulness, and it is equally certain that there is no cheaper or better plan so far evolved that will answer the purpose of giving a new life to the plate bolster. There are thousands of them in service that would have been thrown out long ago but for the immense cost involved.

Mr. Schroyer has substituted short stirrups for the usual spring plank in this truck, and finds that it saves unnecessary weight.

LOCOMOTIVE COAL TESTS.

C., C., C. & St. L. Ry. and Purdue University.

Satisfactory fuel tests on locomotives are very rare, but the use of a locomotive boiler as a coal calorimeter is unique. Mr. Wm. Garstang, Superintendent of Motive Power, C., C. C. & St. L. Ry., read a paper before the Western Railway Club in December which embodied both of these and included a report by Prof. Goss, based on a combinative test made for that road, of five coals, on the Purdue laboratory locomotive, the results of which were afterward checked with locomotives on the road. From these data it was possible to select the fuel that is cheapest to use. It happens in this case that the coal that is best in steaming and evaporative qualities and in respect to ashes, clinkers and cost of handling, is not the cheapest, after all. Of all the coals tested, that which was cheapest in price had the disadvantages of poor steaming qualities, the lowest general efficiency, evaporated the least amount of water, and was high in ash and clinker, and the poorest coal was the cheapest fuel per ton of freight hauled because of its low price. The monthly consumption of the poorest coal would be 8,616 tons more than that of the best to do the same work, and assuming that the cost is $2 a ton, this represents $17,632 per month, which is enough to say of the value of the figures obtained by the tests.

It is clear that elaborate trials offered the only possible method for intelligent comparisons of fuel in this case, and we commend the care, and especially the checking, of the work by the double tests. A 20 by 26 inch consolidation engine was used on the road, and the comparative figures of evaporation are given below. The order of values of the coals from this standpoint is the same in both tests, this fact being a source of satisfaction and confidence in the results.

Coal.	Evaporation in lbs. per pound coal. Laboratory.	Road.	Coal per 1,000 ton miles Road Tests.	Monthly consumption of Coal in tons per 14,000,000 car miles.
E	6.61	6.84	116.800 lbs.	25345.6
A	6.13	6.41	118.075 "	25622.1
B	5.87	6.10	126.350 "	27417.6
D	5.40	5.36	148.725 "	32273.5
C	5.37	4.98	157.425 "	34161.4

The evaporative tests were carried out at two rates, first, when the evaporation per square foot of heating surface was 5 lbs., and, second, when it was 10 lbs. of water. The results with the five coals were as follows:

Coal.	Water per lb. coal. Rate 5.	Rate 10.
E	8.61 lbs.	6.61
A	8.00 "	6.13
B	7.49 "	5.87
D	6.81 "	5.40
C	6.60 "	5.37

While the tests were made only to compare the fuels and not to test the boiler, the decreased efficiencies at the higher rate of evaporation is noteworthy as an incident to the tests.

The data indicate that it is possible for 264 pounds of coal per ton of one of the coals to be wasted from the stack in the form of sparks. Those tests show this result when forcing the boiler to evaporate 10 pounds of water per square foot of heating surface per hour. This will no doubt be a revelation on fuel loss that will strike a hard blow at small heating surfaces when coupled with heavy demands for steam. This has a special significance when compared with a loss of only 75 pounds per ton of fuel from the same causes when the rate of evaporation in the same boiler is but 5 pounds of water per square foot per hour.

The difference in intensity of draft measured in inches of water required for the two rates of evaporation, given above, conveys some idea of the work going on in the firebox between the higher and lower evaporations, the average for the rate of 5 pounds (reduced to ounces), being 1.25 ounces, and that for the rate of 10 pounds being 3.41 ounces, or 2.16 and 5.92 inches of water respectively.

These tests direct attention to the fact that the character of the exhaust action does not materially influence the evaporative efficiency of the boiler, the efficiency being a function of the rate of evaporation, and it does not appear to make any difference how the draft is made, whether by slow, hard blasts or lighter and more rapid ones; if the same draft is produced by both the evaporative efficiency will be the same, and Prof. Goss says: "It implies that tests of fuel for use in locomotives can be made in a fixed boiler as well as in one which is influenced by the motion of the engine. Draft can be produced by a steady flowing steam-jet as effectively as by the pulsating action of the exhaust, so that there seems to be no reason why the whole problem cannot be approached by means of a stationary boiler arranged to give draft conditions comparable with those found in locomotive practice."

The paper presents for the first time the relations between the evaporating efficiency and the draft which must prevail under locomotive conditions for individual coals in order to sustain definite rates of evaporation.

We regret that we cannot print this paper in full, with the diagrams. It should be read by every mechanical and operating railroad officer because of its suggestiveness. Its value as a test is confined to the "Big Four" road, but it suggests the importance of knowing the relative values of available coal on every road.

1899 MAIL SERVICE.

Transcontinental mails have been carried from New York to the Pacific coast in four days since the inauguration of the new mail service, January 1. The first train on the new schedule left New York at 9.15 p. m., January 1, and the mail arrived in San Francisco in 97 hours 55 minutes, an average speed of 34 miles per hour from start to finish. This train was 69 minutes late at Buffalo, 16 minutes late at Cleveland, and arrived in Chicago two minutes ahead of time. It was five minutes ahead at Omaha, 30 minutes late at Ogden, two hours late at Palisade, one hour late at Wadsworth, and arrived on time in San Francisco. The time on the more northerly route to Portland, Oregon, has also been shortened, and the first train reached Portland 95 hours and 55 minutes after leaving New York, which is 15 hours less than by the former schedule.

Some very fast runs are recorded on the section between Chicago and Omaha, which is the fastest part of the runs to the coast. The schedules from New York are as follows:

	Miles.	Time. h. m.	Miles per hour.
To San Francisco	3,332	98	34
Ogden	2,448	66 30	37.51
Council Bluffs	1,464	35 40	41.05
Chicago	964	24 15	39.75

These rates of speed include all stops and transfers. The speed on the Burlington is 48 miles per hour; on the Union Pacific, 1,034 miles, 34.2 miles per hour, and on the Southern Pacific, 834 miles, 27 miles per hour. The schedule time for the runs to San Francisco and Portland is as follows:

Leave New York (N. Y. C.), first day	9.15 p. m.
Arrive Buffalo, second day	8.10 a. m.
Lv. Buffalo (Lake Shore), second day	7.15 a. m.
Arr. Chicago, second day	8.30 p. m.
Lv. Chicago (Burlington), second day	9.30 p. m.
Arr. Council Bluffs, third day	7.55 a. m.
Lv. Council Bluffs (U. P.), third day	8.30 a. m.
Arr. Cheyenne (U. P.), third day	10.25 p. m.
Lv. Cheyenne (U. P.), third day	10.45 p. m.
Arr. Ogden, fourth day	1.45 p. m.
Lv. Ogden (Southern Pacific), fourth day	1.10 p. m.
Arr. Reno, Nevada, fifth day	9.05 a. m.
Arr. Sacramento, fifth day	4.00 p. m.
Arr. San Francisco, fifth day	8.15 p. m.
To Green River (Oregon Short Line), fourth day	8.30 a. m.
Arr. Portland (O., R. & N.), fifth day	5.15 p. m.

The changes of time must be kept in mind in reading this schedule.

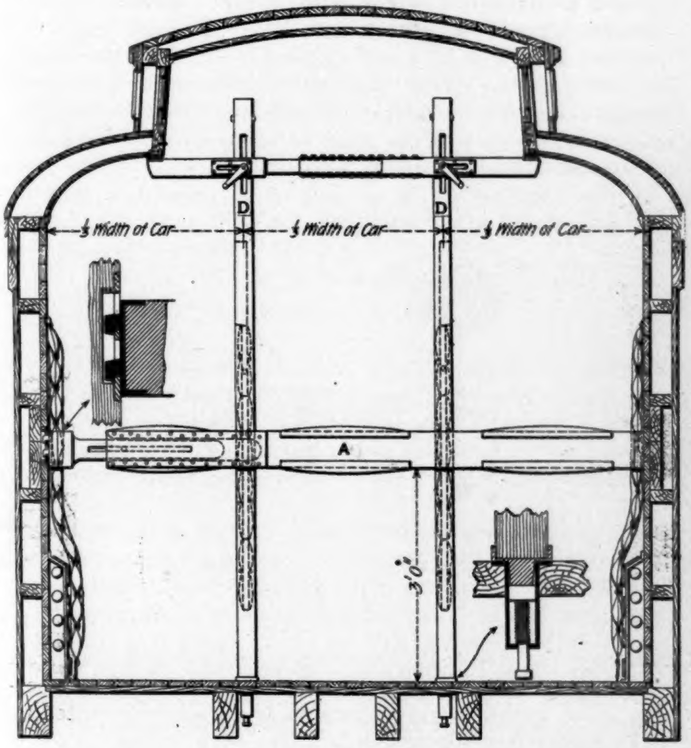
COMPRESSED AIR MOTOR TRUCKS IN NEW YORK.

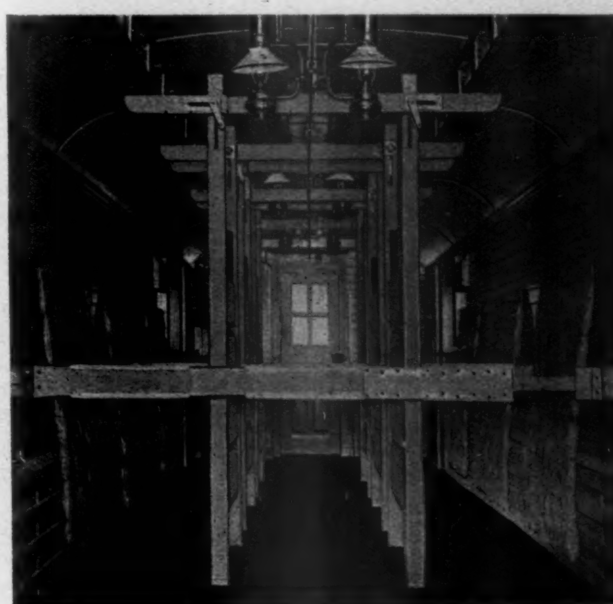
A contract for building 250 trucks, having compressed air as a motive power, to be used on the streets of New York City, indicates the extent of an experiment to be tried by the International Air Power Company. These trucks will be built under the Hoadley & Knight patents, and will be designed for heavy and light service. Three charging stations will probably be put in at different points in the southern end of the city, for the purpose of avoiding long journeys for replenishing the power supply. The trucks will be arranged to pull other trucks, or to be pulled by others, but the details of the designs are not yet known. With the plant of the Rhode Island Locomotive Works equipped for the purpose, a large capacity for the production of this type of motor carriages will be available.

RAILROAD PORTABLE HORSE STALL.

The New York, New Haven & Hartford Railroad has fitted up several baggage cars with portable stalls for the transportation of horses, in accordance with a plan devised and patented by Mr. J. P. Young, of New Haven, and applied under the direction of Mr. W. P. Appleyard, Master Car Builder. The system as shown in our illustration has the merit of simplicity, which implies facility of application and removal, two points making it specially valuable to railroad companies that have to take care of intermittent transportation of valuable horses. The details of this device are capable of any amount of expansion or contraction. A 60-foot baggage car will take 16 complete stalls and leave room to pass through the car, leaving room also between the side doors. Thirteen stalls may be built in a 50-foot baggage car, and an ordinary box car may also be fitted with them, but of course they will have a reduced capacity for horses.

The time required to fit up a 60-foot baggage car is only thirteen minutes for two men, and the work is done without any tools whatever, all fastenings being an integral part of the stall equipment. The posts D are spaced about 6 feet apart between centers longitudinally of the car, and the width is divided up into three stalls. The bottom of the posts D are dropped into pockets let into the floor, and rest on springs under the pockets. The partition bar A is shown with its extensible part at the left. A larger sized detail of the end of this bar and also of the pocket and spring for post D are shown in the illustration, giving a better idea of the construction than is possible from the general elevation. The method for securing the posts D at the top, as shown, makes it clear why the fittings can be so quickly applied where necessary to use a car for stock transportation. Those at the Master Mechanics and Master Car Builders' Convention at Saratoga in 1898 will remember the favorable comments made on the baggage car fitted up with this equipment, which was exhibited there. On the New York, New Haven & Hartford the stalls and cushions are stored at terminals from which horses are likely to be shipped, and an ordinary baggage car is made ready for them at very short notice. The advantages of such a plan are apparent.





Young's Portable Horse Stall for Baggage Cars.

HOMOGENEITY IN BEARING METALS.

In discussing the subject of journal bearings before the Southern and Southwestern Railway Club in November, 1898, Mr. W. E. Symons, Superintendent of Motive Power of the Plant System, referred to the necessity for careful manufacture of bearings by calling attention to the article on "The Microstructure of Bearing Metals," by Mr. G. H. Clamer, printed in our September, 1898, issue, as follows:

"It is my opinion that if railway companies could secure and use altogether a journal bearing metal as shown in Figures 7, 8, 9 and 10 (See American Engineer, September, 1898, page 315), no matter by what company the same may be made, that our troubles would about all cease that are attributable to the quality of the brass."

The metals referred to by Mr. Symons are as follows: Figure 7—Copper, tin, lead and phosphorus; a phosphor bronze, first melting. Figure 8—Copper, tin, lead and phosphorus; a phosphor bronze, remelted repeatedly. Figure 9—Copper, tin and lead; first melting. Figure 10—Copper, tin and lead after repeated meltings. The last mentioned alloy is made by the Ajax Metal Company's process, which assures the homogeneous distribution of the lead. The peculiar action of lead in alloys requiries most careful manipulation, because it does not combine with copper and tin, and on account of its high specific gravity and low melting point it tends to go to that part of the casting which solidifies last and to distribute itself unevenly throughout the mass. The success attained in this process is clearly shown by the appearance of the prints from etched sections in the article referred to. The smoothness and evenness of distribution in Figure 10 is remarkable, and the service records of the metal support the expectation that evenness of bearing action will result. Mr. Symons' testimony in this connection is suggestive.

The number of telephones in use in all countries, as compiled by the Swedish government and reported by Consul-General Edward D. Winslow from Stockholm, is 1,288,163, and the total distance covered is 1,504,499 miles, or more than a mile for each instrument. At the time of the record the United States had 772,627 instruments, Germany 151,101, and Great Britain 69,645.

UNDERHUNG DRIVING SPRING RIGGING.

By L. R. Pomeroy.

It is not long since all driving spring rigging was placed above the frames, but the increasing demands on motive power have forced designers to employ the largest boilers which they could crowd into the limits to which they are restricted. A substantial improvement has been made by placing the fire box on top of the frames, which made the width between the wheels the limiting one, instead of between the frames, whereby nearly if not quite 8 inches are gained in width. Designers were then forced to employ underhung spring rigging, and so far as such designs have followed the general principles involved in the best arrangements of overhung springs, there has been no more trouble with the underhung than with overhung rigging. The popular and successful type of overhung spring rigging has been the result of a long process of evolution and experience, and it would seem to be good practice to utilize this experience so far as the new conditions permit, and the only arrangements of springs that have been unsatisfactory have been those in which a departure has been made from long established and successful precedents. The difficulty is two-fold:

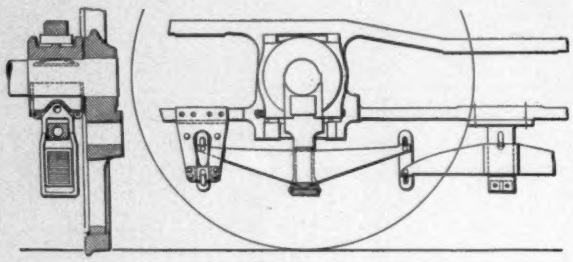


Fig. 1.

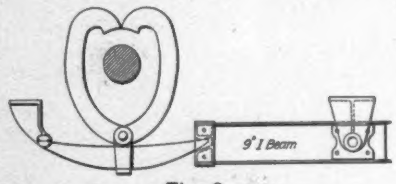


Fig. 2.

First.—Where driving springs have been so connected as to provide sliding (and chafing) contact at their ends. Hangers or swinging links are provided almost universally as a means of spring suspension in foreign practice, and this principle is commonly employed in engine trucks in preference to permitting the springs to bear at their ends. Recent experience with springs having sliding contacts goes to show that the destruction of the spring is very rapid, and the use of links has demonstrated in a practical way that springs fitted with them do not receive the punishment to which the others are subjected.

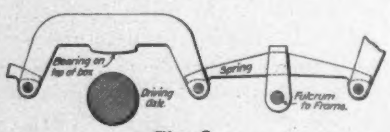


Fig. 3.

Second.—Such an arrangement of springs and equalizers, with reference to their points of suspension as will cause the hangers, connecting the equalizers with springs, to pull away from the vertical plane. Such arrangements cause rapid wear and unsatisfactory movements, because strains are produced for which no provision has been made.

It is unnecessary to dwell upon the effects of these faults, it being sufficient to call attention to the fact that good designing demands the relief of heavy loaded springs of this type, from sliding friction at their ends, and they should also be relieved of the stresses imposed by hangers which pull out of the vertical to an unnecessary extent. There is little or no excuse for the failures that have recently been made, when these principles have been neglected, because this ground has all been gone over thoroughly by others, whose experience has been available to all. For example, Fig. 1 is submitted as a successful example which was made from an engine built over ten years ago. Figs. 2, 3 and 4 illustrate examples where suspension from the spring band is combined with rubbing or chafing at the ends of the springs. Fig. 5 is a conventional diagram to illustrate how the point of suspension influences the path of the hangers.

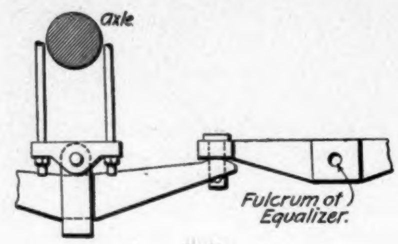


Fig. 4.

In Fig. 5 the arc x x_1 is the path of the suspension point at the end of the equalizer. Assuming the spring to be hung from the top of band or buckle, as at A, then the path of the suspension point at the end of the spring is an arc represented by Z, Z_1, struck from the center A. The path of the hanger is determined by these arcs, and they are so located as to tend to change the angle between the hanger and the vertical line very rapidly. In a word, the only time the hanger remains vertical is when the engine is at rest; just as soon as any movement occurs the spring and equalizer tend to pull apart.

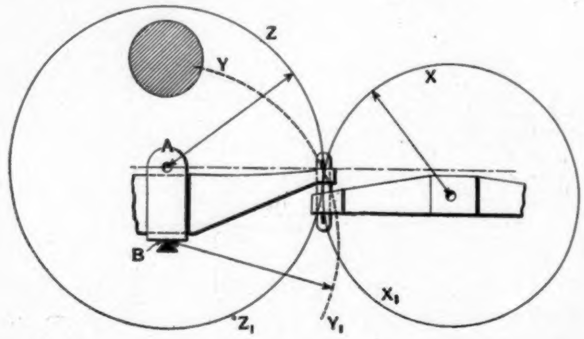


Fig. 5

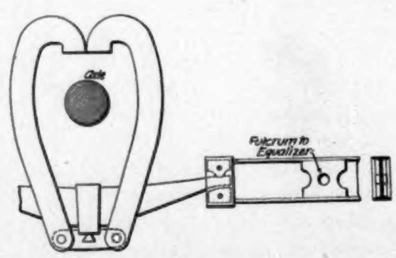


Fig. 6.

When the spring rests in a stirrup the center of movement is around or about point "B," and the arc of movement of the suspension point at the end of the spring is located at y, y_1. The radius is slightly increased; this and the lowering of the center of rotation causes the arc y, y_1 to inter-

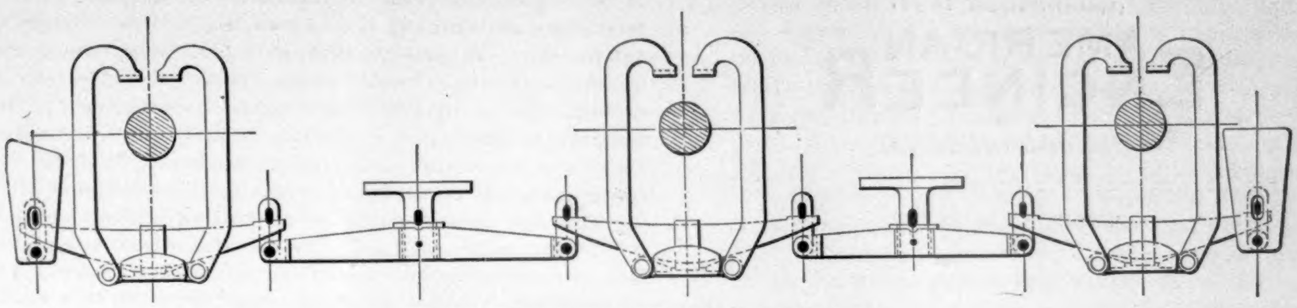


Fig. 7.—Arrangement of Equalizers and Springs.

sect the arc x x_1, instead of being nearly tangent to it as before, and the movement of the hanger is so changed as to keep it in a nearly vertical position. Various dimensions may be given for the parts shown in this diagram, but such an arrangement of centers of rotation, or such a combination between length of spring and equalizers, should be selected as will tend to keep the hanger as nearly vertical as possible. When the spring rests on a stirrup, as at B, Fig. 5, it has a bearing on the bottom, and more nearly approximates the conditions existing with the best forms of overhung springs; again, such a bearing tends to produce a more even and deliberate movement of the spring, whereas, when hung from the top of the band at A, the spring is then suspended from a point, which tends to promote a more rapid vibratory movement.

Fig. 6 is added to show a modification of Fig. 2, and Fig. 7 to show an example of good practice.

JOURNAL BOX LIDS.

There appears to be some quiet investigation of the question of dust exclusion by the M. C. B. journal box lid by Messrs. McCarty, Petri and Butler, a committee of the Central Railway Club, whose findings were embodied in a report at the November meeting of the club. Some of their conclusions are given below:

The form of the M. C. B. journal box lid was wrong in principle, and consequently under the usual methods employed in making and fitting freight car boxes and lids it was difficult, if not impossible, to secure a close fitting lid, as the face of the lid and box were irregular in form. In the opinion of the committee a careful consideration of the question would result in the conclusion that the most economical form of journal box would be one having a perfectly flat surface for the lid to rest upon, and where the action of the spring would be most effective. These features were all embodied in the Fletcher lid. It was well understood that the moment a train stirs up much dust and dirt that beats against the forward side of the box the lid exposed to this action would be affected to a greater or less extent. This had been overcome by hanging the Fletcher lid at the top and forming a ledge or rib on each side of the box, which effectually resists the action of the dust and dirt, as with this construction there were no exposed joints at the sides of the box.

By a comparative trial on passenger cars, extending over a period of one and a half years, it was shown that boxes with close fitting lids required 50 per cent. less oil and packing than boxes with the M. C. B. form of lid. One form of lid in this comparative test was a cast iron sliding lid, fitting ledges on each side of the box, which, as well as the lid, were machine fitted by an economical process. This lid gave better results than the Fletcher. This sliding lid was not a new form, having been in use for at least 30 years on a railroad where the conditions were most severe in regard to sand and dust. During this long period this lid had shown a saving of over 50 per cent. in the amount of care required in oiling and packing the boxes, as well as an equal saving in the quantity of oil and packing used, as compared with the M. C. B. lid in the same service.

This test also showed a great saving in wear of the journal, both in diameter and end wear, being a reduction of wear on the parts referred to of 50 per cent. and in many cases more than that, as compared with the M. C. B. lid. The committee did not consider the M. C. B. lid as meeting the requirements for the complete exclusion of dust and dirt.

This report is likely to reopen the box lid question, with the ultimate result of a change in form of what is now the M. C. B. standard, for the reason that the reported oil saving will be a powerful incentive to produce such action. We shall take occasion in this connection to again call attention to the need of a dust excluding device at the rear of a journal box. Protection is required at that point, and the question as to how much that 50 per cent. saving might be increased by the use of an efficient dust guard is a pertinent one, for it is well understood that dust guards are now allowed to run with an area of opening not less, and often greater, than that in the poorest fitting box lid.

The Hon. Chauncey M. Depew, Chairman of the Executive Board of the New York Central & Hudson River Railroad, has been elected United States Senator for New York State. This election of a lifelong railroad man to the council halls of the nation marks a new departure in the politics of this country. The Republican Club, of which Mr. Depew is President, gave the Senator-elect a dinner in honor of his election. Among other speakers on this occasion was Mr. George H. Daniels, General Passenger Agent of the New York Central, who gave in his customary happy manner some of the reasons why the choice of Mr. Depew to represent the people of New York in the Senate was a wise one. Mr. Daniels having been identified with transportation interests from his boyhood, is well qualified to speak of this change in sentiment with regard to railroad men, and among other good things he said: "It is to my mind peculiarly fitting that just at this time, when transportation is occupying so large a place in the public mind, not only in this country, but in every country on the globe, the Empire State of the Union should select as its representative in the most important legislative body in the world a man whose whole life has been spent in the closest association with the transportation interests of the country, and that, notwithstanding the prejudice which has so long existed in the minds of many otherwise fair-minded men against railroad officials as such, the representatives of his party have paid a railroad man the unprecedented compliment of a unanimous vote for the most important position within their gift."

"To think straight and not let one's self be led into tortuous ways by inessential details is, I think, the most difficult thing in affairs mechanical." This paragraph is quoted from the correspondence of a young mechanical engineer, and while it is nothing more or less than "common sense," how uncommon it is to find men who keep this idea in mind in their work. A man who puts such a sentiment into private correspondence may be expected to be successful, and he is successful.

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Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, sends us the most important contribution on the subject of discipline that has ever been published. It is printed in this issue and the words of the founder of "Discipline Without Suspension," after years of experience with the system, are impressive. In his annual report of 1898 to his superiors Mr. Brown said: "Better men, better discipline mean better results." One of the results is the record of the Fall Brook Railway for not in its history having killed or even seriously injured a single passenger.

The communication from Mr. A. E. Outerbridge on another page of this issue on "Cast Iron in Railway Practice," called forth by the article by Messrs. Henderson and Davis in our January number, is of special interest because of the importance of the cast iron car wheel, than which nothing but the improvements in steel rail making has contributed more to the extraordinary development of American railroads. Mr. Outerbridge is entitled to the credit of the introduction of the use of ferro-manganese, and the publication of the paper read by him before the Franklin Institute in March, 1888, brought inquiries from car wheel manufacturers all over the country leading to the improvement of the wheels. We have been intrusted with the records of the original investigations by Mr. Outerbridge, which were undertaken in 1883, and it was a most elaborate, painstaking and thorough research. It shows how the ground was covered, and indicates the amount of time, thought and money expended in putting a crude suggestion into practicable form. The cast iron wheel with chilled face, as made by the best manufacturers to-day, is a product to be proud of. It is not the result of accident, but of scientific study of the highest character.

There appears to be a renewal of attention to the inspection of watches used in railroad service. While watch inspection and regulation has been practiced on many roads for some years past, and has been found to be most satisfactory in results, it appears that there is a lack of proper appreciation of this safeguard in train management. Watches in the hands of some men are regarded in the same light as any other piece of machinery, and if there is an inherent disposition to let such mechanism take care of itself there is but one result to be expected. For that reason, if no other, compulsory inspection and regulation is an absolute necessity on railroads. The interests at stake are too great to permit of taking chances that are sure to bring disaster to life and property by way of a defective watch, and we are glad to note this revival of interest. We have noted a resentful disposition in some cases to what is termed the paternal tendencies of railroads, but it has been shown only by those who were in chronic opposition to every improvement in the service.

AIR BRAKES ON CARS OF LARGE CAPACITY.

It is not unnatural that the question of the adequacy of present brake power upon freight cars of moderate weight, designed to carry heavy loads to meet the practical requirements of service, should receive some discussion. If the present tendency to increase the capacity of cars should continue, it is possible that the conditions may become such as will warrant increased braking capacity for freight cars. It is, nevertheless, the fact that, so far as the study of the subject of providing different braking powers for light and loaded cars has progressed a considerably more complicated apparatus to attain this end seems inevitable. To add complications to the air brake apparatus already in use upon freight cars seems at the present time to be not only unwarranted, but also extremely undesirable. We find that a number of cases have been brought to the attention of the Westinghouse Air Brake Company in which it was complained that serious difficulty and even danger attended the handling of heavy trains upon heavy grades. and in each such instance careful investigation on the part of the brake company brought out the fact that either the brake gear was not suitably applied to the cars, or that the brake apparatus was not properly cared for or maintained in operative condition. The latter has been found to be the chief cause of trouble. In most instances the trouble has been found to be due to neglect of the apparatus. In all of these cases, however, careful investigation, provided convincing evidence to the railroads that with proper application and care of the air brake apparatus now in use, it is fully capable of meeting all the requirements of service, even under extreme conditions.

The difficulty of applying suitable brake gear is frequently found to be one of the obstacles to securing efficient operation of the airbrake on freight cars. Freight trucks are often so designed that it is almost impossible to hang the brake beams in a manner to secure uniform and efficient service of the apparatus. It has been demonstrated that if freight trucks were designed with sufficient wheel base and in a manner to permit

the use of proper brake hangings, the efficiency of the brakes might be much increased. As freight trucks are now constructed, it is almost impossible to hang the brakes so as to secure anything like a proper efficiency.

Investigation of the condition of brake equipment of cars on many roads indicates that the use of a suitable slack adjuster to maintain the proper piston travel would go far toward remedying that species of neglect which results in the extreme movement of the brake cylinder piston and the consequent inefficiency of the brakes. A satisfactory device of this kind is available and its application is strongly urged.

The inspection and cleaning of brake cylinders and triple valves is, no doubt, receiving far more attention than it has in the past; but it is nevertheless true that there is room for great improvement in this direction. Until the time shall come when the railroad companies are fully alive to the necessity of properly maintaining and caring for the apparatus which they now have upon their freight cars, it is manifest that a further complication of the apparatus to secure a variable braking power, in accordance with the variations of load, would not only be wholly undesirable, but would probably prove to be a source of danger to the safe movement of trains, on acccount of the much greater proportion of defective brakes that would have to be cut out of service. At any rate, it would seem to be a wise course on the part of the railroads to first demonstrate that with proper application and suitable care of the apparatus they now have, the conditions of service are not safely and satisfactorily met.

GASOLINE AND OIL ENGINES FOR PUMPING STATIONS.

Gasoline engines are specially well adapted to the pumping of water at railroad water stations, and their use is sure to become much more general as the advantages they offer are brought to notice. They are economical in cost of fuel and also in maintenance, when good designs are selected, but their greatest advantages are economy in attention required and the freedom from wastefulness when not running. When the engine is stopped all expense stops, while the cost of fuel required to keep up steam in even a small boiler is not by any means negligible. In passing, it should be noted that a gas engine may also serve to furnish other power, such as the operation of coal chute hoists and the driving of electric-light generators.

The Chicago & Northwestern Railway has a 34-horse power gasoline engine at La Fox, Ill., that is fitted up to run a pump furnishing 2,300 gallons of water per hour to a tank elevated 46 feet above the ground level, and also a 12½ kilowatt generator furnishing light for the yards and buildings in the vicinity. The engine uses two gallons of oil per hour while running both the pump and the generator at their full capacities, and the oil costs five cents per gallon, the cost of fuel being stated to be one-half cent per horse power per hour. There are 55 16-candle power incandescent and five arc lights arranged on separate circuits. The attendance required is stated to be one-half hour per day, but considering the attention that lights require this is probably an underestimate. It is sufficient to say that the engine does not usually require any attention except to start, stop and lubricate it, and this may be done by a man who is engaged in other duties for the greater part of his time.

These engines have been very successful in municipal waterworks for handling small additional supplies of water or for use in relieving previously installed steam plants. Several applications of this kind are mentioned by Mr. F. C. Coffin in a paper read a short time ago before the New England Water-Works Association. The first of three plants described was put in to pump an additional supply from driven wells for the Cohasset, Mass., Water Company, and conditions required that the supply was to be obtained at the minimum cost. The engine was guaranteed to develop 13 horse power at the rate of one pound of oil per horse power per hour, the oil to be 150 degrees test. The test showed a consumption of 1.3 pounds of oil per horse power per hour, including the friction of the pump, and the engine alone developed 15 horse power by a consumption of 0.926 pounds of oil per horse power per hour. This plant lifted water about 160 feet, and it worked 115 days with no attention except to oil it and start it in the morning and stop it at night. During the day the building containing the plant was locked up. Mr. Coffin installed a 20-horse power oil engine with a pump capacity for pumping 350 gallons per minute against a head of 142 feet in the high pressure water system of Winchester, Mass. In a test it showed 11,516,518 foot pounds of work on a consumption of a gallon of oil, and this whole plant, exclusive of building and foundation, cost about $2,900.

Mr. Coffin's experience indicates that a well designed oil engine plant will pump a million gallons of water one foot high for each gallon of oil consumed. This is at the rate of one pound of oil per horse power per hour and allows a loss of .35 per cent. in the pump. Gasoline engines do a little better than this, both oil and gasoline being cheaper than gas in the following proportion: For pumping one million gallons water one foot high the cost will be:

Oil at 9 cents per gallon.	Gasoline at 9 cents per gallon.	Gas at $1.00 per 1,000 ft.
9 cents.	8.1 cents.	13 cents.

In comparing the cost of installation, attendance, supplies, repairs and fuel for steam and internal combustion engines it was found that for the same work done the annual cost of supplies and repairs was a little more for the compound steam engine, the cost of attendance was at 3 to 8 in favor of the internal combustion engine, and in cost of interest and depreciation the internal combustion engine had an advantage over steam represented by the ratio of 7.5 to 10. These figures were made on a basis that was not intended to favor either type of engine. This outline of the possibilities of the gasoline and oil engine appears to justify the conclusion that railroads can afford to discard many of their present steam pumping plants in favor of the internal combustion engines, but caution should be observed in getting an engine of this type large enough for its work, because if overloaded they will slow down and stop working.

FREIGHT CAR CENTER PLATES.

In considering increased train resistance on curves, the causes therefor, and the resulting sharp wheel flanges, stress has been laid upon the weakness of some bolsters, which allowed contact of side bearings, as the principal factor in the waste of the power of the locomotive, by reason of the friction due to such contact, but it appears that little attention has been given to the same cause for complaint in regard to center plates. That such friction is present, and of such magnitude as to demand a remedy, is well known, and taken in connection with weak bolsters with their accompanying friction of side bearings, we find a condition that must be improved if curve resistance and flange wear are to be reduced. This resistance should be made as low as possible by reducing the friction of these parts, no matter whether they are viewed separately or together, and the question of whether a bolster should be allowed to deflect, and thus have the advantage of light and therefore cheaper construction with its attendant deformation of the superstructure, or whether it should be made stiff enough to carry the load free from the side bearings, and thus make it possible to provide for the friction of the center plates only, does not alter the proposition that the time is come for improving center plates.

In a review of the side-bearing question in our issue of September, 1898, page 306, we suggested that the man who had a good frictionless side-bearing should bring it forward, and at the same time intimated that it is "worth while to

consider whether an anti-friction center plate bearing is not equally important." No other confirmation is necessary than the examination of the center plates under heavy freight cars, which will show but little increase of bearing area over the practice long used on lighter cars. When such inadequate bearing surfaces and the load on them are taken into account, with the surfaces not only dry, but of the roughest character, and also working on an abrasive of grit, it is plain that resistances are at work at the truck that call for a greater expenditure of power at the engine than would exist if this friction could be eliminated, or at least reduced. Any improvement in the condition of the bearing parts would make center plates vastly superior to those now regarded as good enough, and there is no doubt that such improvement, if carried to the extent of machining the surfaces, would pay. There is one course open to all by which an improvement may be effected even with the center plates as they stand with their imperfections, namely, to lubricate them.

The Lake Erie and Western has made a practical test of lubricating rough cast iron center plates, with a resulting total absence of flange wear, but the plates were designed to exclude dust and grit. The Northern Pacific has also recently begun the use of lubricated center plates of cast steel, the upper plate is cast so as to retain the oil placed therein, and rests on a loose liner interposed between the two plates. Provision is made for oiling in both these cases by means of an oil duct cast at the side. These two instances of improved center plates indicate the beginning of a better understanding of a detail that has been badly neglected, and the report of ball-bearing center plates in use on the Sea Board Air Line is still further evidence of the same kind.

The idea sometimes entertained that a freight car must be built in the roughest manner because of its service, is a fallacious one, as has been found in connection with details other than those discussed here. Unnecessary refinement is not advocated for freight car work, but we would like to impress the need of mechanical work on details like center plates. To illustrate the different estimates of the relative value of like work on a locomotive and car, it is a fact that the center bearing of a locomotive is almost invariably machined for the purpose of giving freedom of motion to the truck, and thus preventing any tendency to cut flanges or cause derailment through failure to follow the track properly. While on the other hand, the freight car which should be made to give the same results and by the same means, is left to work out its own salvation with center plates in a condition not considered fit to run on a locomotive. It is not easy to account for this inconsistency on any other ground than failure to attack the problem from a mechanical standpoint.

POWERFUL PASSENGER LOCOMOTIVES FOR FAST TRAINS.

Several roads are getting out designs for locomotives to haul heavy and fast passenger trains, for which unusual power long sustained is required. Among the features from which most is expected are large boilers, large and direct steam passages, easily moving valves, large driving wheels and better methods of getting work out of the steam.

The last of these is the most difficult, and the most noteworthy information that has appeared in this connection recently was given in Prof. Smart's paper before the St. Louis Railway Club in February, 1898, giving results of laboratory tests of a model Vauclain four-cylinder compound locomotive at Purdue University. (See American Engineer, May, 1898, page 163.) The results obtained by Prof. Smart were corroborated before the same club at the November meeting by Mr. S. M. Vauclain, and the two papers should be read by all who are working on this problem. While both of these gentlemen present figures of more favorable steam consumption for the compound, interest centers in the fact that up to the highest limits of speed attained, the power of this type of locomotive increases in constant ratio with the speed. The diagram, Fig. 1, on page 163 of our May, 1898, issue, shows the horse power lines of the Purdue model locomotive to be straight. Prof. Smart found that instead of a rapid falling off in power, that accompanies increase of speed in ordinary simple engines, the change in the steam distribution in this four-cylinder compound gave increased horse power and increased economy up to 270 revolutions per minute, the limit of the tests, and the slope of the horse power line tended to show that the power continued to increase for much higher speeds. Whereas the simple laboratory locomotive gave curved lines, showing that the power reached its maximum at about 240 revolutions per minute, and then fell rapidly away.

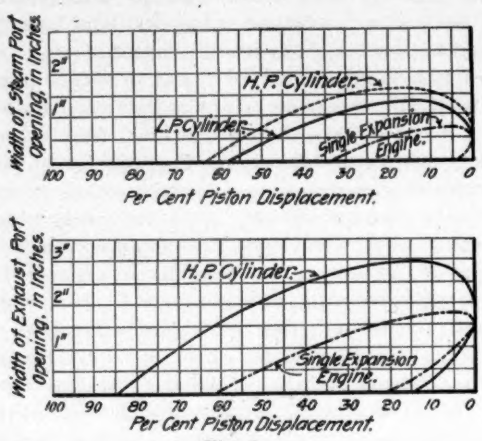


Fig. 1.

Mr. Vauclain has added testimony from data taken from the engine of the "Atlantic City Flyer" (American Engineer, December, 1897, page 326, and October, 1898, page 341), and the "Atlantic" type engines of the Chicago, Milwaukee & St. Paul (American Engineer, August, 1896, page 170). He presented diagrams, Fig. 1, of the port openings of this type of compounds compared with simple engines, and attributed the advantage of the compound over the simple engine to the valve motion, and the fact that the steam and exhaust ports of this compound remain open longer than those of the simple engine. The effect of this appears in the absence of back pressure and wire drawing in comparative indicator cards, and the difference between the cards from the compound and simple engines is remarkable. The diagram of the horse power of the Atlantic City engine, above 220 revolutions per minute,

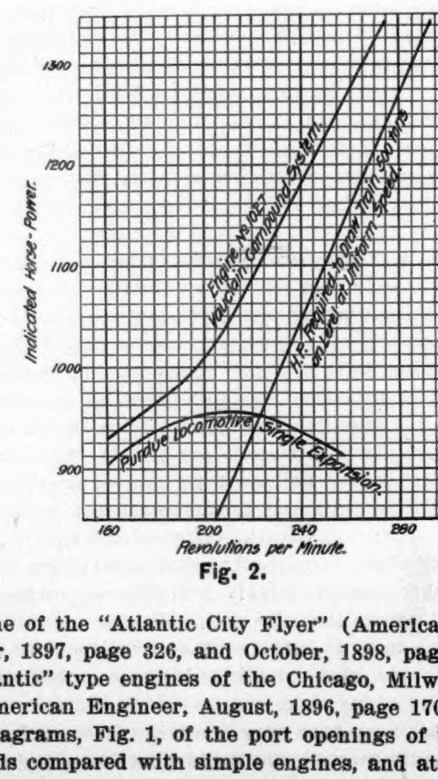


Fig. 2.

becomes a straight line similar to those secured by Prof. Smart. They indicate that the horse power increased in a direct proportion to the speed until 1,450 horse power at 70 miles per hour was reached, and the power line was straight at that point. This does not accord with the theory of critical speed by Prof. Goss, and while the increase of power in direct ratio with the increase of speed is difficult to comprehend, these records appear to establish this as a fact. It is noteworthy that the increase of power with the increase of speed was greater in the case of the road engine than in the Purdue model. Fig. 2 compares the power of the Atlantic City engine with the Purdue simple engine known as "Schenectady No. 1," and Fig. 3, reproduced

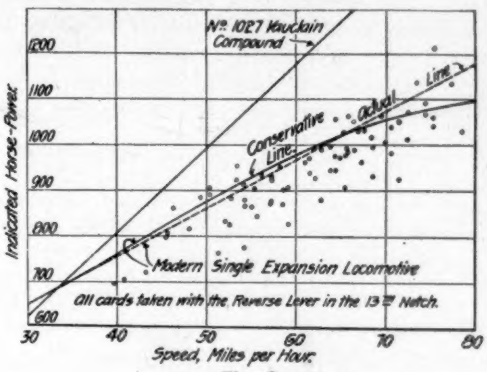


Fig. 3.

from Fig. 18 of Mr. Vauclain's discussion, compares the Atlantic City engine, No. 1027, with "a single expansion engine," and the straight line for this engine was plotted from the actual results, the curved line having been laid down through conservatism and lack of confidence in several of the cards. The divergence of these two straight lines, according to Mr. Vauclain, represents the advantage from compounding. He further states that properly designed valve motion will enable a simple engine to show an increase of horse power in the form of a straight line, and that the line will be straight up to the limit of the endurance of the engine.

Accepting the statements concerning the model and the Atlantic City engine as careful and accurate, to what do they point?

Mr. Vauclain attributes the whole to the compounding, we may say to this particular type of compounding, and chiefly to the superior action of the valve motion. He does not go into details, and after stating a strong case for the compound he does not state why the simple engine cannot be made to equal this performance. It is to be presumed that the simple engine selected for comparison with the compound was comparable with it, but the great importance of the conclusions merits further elaboration. In the case of the laboratory model at Purdue the steam was taken from stationary boilers, which to a certain extent deprives Prof. Smart's results of the advantage of direct comparison with road practice.

Dividing the work up into four cylinders probably has a great deal of influence on the power at high speeds. It permits of using the valve motion more favorably, because of deferring the cut off, and the amount of steam to pass through any one pair of ports is less than with two cylinder engines. A 14 and 20 by 24-inch Vauclain compound cutting off at half stroke will use about 1,800 cubic inches of steam per stroke of one high-pressure cylinder, whereas a simple engine of the same tractive power will use about 2,300 cubic inches to do the same work. This statement is approximate only, but it is sufficient to indicate that less steam passes through the ports of this type than through those of a simple engine to do the same work.

The influence of the boiler power is, however, a vital one in comparing locomotives, and the Atlantic City engine certainly has an advantage in this respect over most passenger engines. This engine can haul a train weighing 606,500 pounds 55½ miles in 47½ minutes, in regular service, an average speed of 70.08 miles per hour, and the boiler furnishes steam enough to keep the pressure within 3 pounds of 205 pounds per square inch for the entire run. The grate area is over 75 square feet, and the driving wheels are 84¼ inches in diameter, both of which are also favorable to sustained power at high speed.

It is clear that this discussion touches the most important questions of design of heavy and fast passenger locomotives, but they are not solved until the proportion of effect of other features than the cylinders in these excellent results is known.

NOTES.

The torpedo boat "Farragut" in her recent official trial is reported to have made the record of 30.6 knots per hour with 426 revolutions per minute.

Great interest is taken in the Universal Exposition to be held in Paris in 1900 by American manufacturers. Commissioner General Ferdinand W. Peck states that our manufacturers alone have applied for ten times as much space as is available.

"When I visited America in 1884," said Mr. W. H. Preece, of London, in a recent address, "there was only one experimental electric railway line at work, in Cleveland, Ohio. Now there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom."

Serious damage to rails on the Wabash Railway by hauling a disconnected engine at a speed of about 40 miles per hour is reported in "The Railway and Engineering Review." Ten rails were broken and 772 were so badly surface-bent as to require their removal. The rail weighed 63 lbs. per yard and the driving wheels of the engine were 56 in. in diameter. The road has a rule limiting the speed of disconnected engines to 20 miles per hour.

The subject of hot boxes was accorded interesting discussion at the last two sessions of the Chicago Car Foremen's Association, says the "Railway Master Mechanic." There are various causes for hot boxes, but the trouble is that these causes are not always accurately determined. Mr. J. N. Barr, in addressing the Association at the last meeting, made the excellent suggestion that the better way to adopt in studying the causes of hot boxes would be to systematically examine boxes that are just a little hot, and not wait until everything was so hot and in such a shape as to conceal the initial cause of the trouble.

One of the most interesting features of the Paris Exposition to the railroad man will be the monster relief map of the railways of the United States, showing every railroad, telegraph, telephone and express line, besides the Great Lake steamship lines and transatlantic steamship ports. The gigantic proportions of this map may be imagined when it is stated that more than one-half the world's railroad mileage is in this country. This map is to be made on a scale of one inch to the mile, and to make the proposed exhibit properly at this scale, the map will be 140 feet high and 230 feet long—a surface of 32,200 square feet. The estimated cost of this undertaking is $100,000.

The importance of the heat treatment of steel was emphasized by Mr. H. V. Wille before the Franklin Institute last month. He had tested a sample which, when judged by the tensile strength, reduction of area, elongation and chemical analysis, would be regarded as the highest grade of material, and, in fact, it passed two inspections on such tests. Notwithstanding the results of these tests, the plate cracked in numerous places between holes when an effort was made to roll it to a 60-inch ring. A test was now cut from the plate, and failed, in an ordinary cold bend; but a second test cut

from the same portion of the plate, when heated to dull cherry and quenched in water, bent flat without signs of distress, proving that a good plate of steel was injured by finishing at an improper temperature. Its tensile strength was 59,200 pounds per square inch, elongation 28 per cent. in 8 inches and reduction of areas 50.2 per cent. The carbon was 0.24; manganese, 0.39; phosphorus, 0.012; sulphur, 0.020, and silicon, 0.02.

The Massachusetts Institute of Technology received over $968,000 during the year 1898, and, according to the President's annual report, $400,000 more is expected. The cost of instructing each student, including the expense of the laboratories and shops, is $330 per year, and the tuition fee is $200. The deficiency is made up by State and individual gifts. The number of instructors is unusual, the proportion being one to every eight or nine students, and this is not counting the lecturers, who are not permanently connected with the school. The school is comparatively young, and is probably only beginning to receive the support of alumni that forms a large part of the financial assistance of most colleges.

The 8-inch Gatling, one-piece, cast steel gun, the preliminary trial of which at Sandy Hook was noted last month, burst on the firing of the fifteenth charge at a pressure of 36,500 pounds per square inch. This pressure was not far from the maximum recorded for the first five proof shots, the highest being 37,000 pounds from a charge of 142 pounds of Dupont brown prismatic powder. An appropriation of $40,000 was made by Congress for the construction of this gun, and it was expected to prove that guns may be made in one piece of cast steel at an immense saving over present methods. Dr. Gatling attributes the failure to the over-annealing of the breech of the gun during its manufacture. On page 18 of our January issue we mentioned the process of pouring.

The new White Star liner "Oceanic," the largest ship in the world, was launched Jan. 14 at Belfast, Ireland. In our issue of July, 1847, page 232, the chief features of the ship were described. She has the following dimensions: Length, 705 feet; beam, 68 feet; draft, 27 feet; gross registered tonnage, 17,040; horse power, 28,000; speed, 21 knots. Comfort and regularity are considered as more important than speed and the arrivals of the ship are expected to be as regular as those of the best railroad trains. It is interesting to know that all of the White Star liners have been built by Messrs. Harland & Wolff, of Belfast, and, including the "Oceanic," they have all been built upon honor and without a contract between the owners and the builders. This tribute to the integrity of the firm deserves thoughtful consideration.

That steel increases in strength a few days after the completion of manufacture was shown by a report of a series of tests by Mr. A. A. Stevenson, of the Standard Steel Company, Burnham, Pa., offered in discussion before the Franklin Institute. (See Journal, Franklin Institute, January, 1899.) Mr. Stevenson, in testing specimens from locomotive tires, found the following results from specimens tested at the same speed:

Dimensions.	Elastic limit.	Ultimate strength.	Elongation. Per cent.	Reduction. Per cent.	Remarks.
2 x 0.500	53,490	107,460	15	19.20	Pulled within three days after tire was made.
2 x 0.500	56,037	108,700	16.30	24.30	Ten days later.
2 x 0.500	50,940	99,590	14	22.20	Pulled within three days after tire was made.
2 x 0.500	53,000	103,464	18	27.40	Ten days later.
2 x 0.500	56,037	111,050	10	12.37	Pulled within three days after tire was made.
2 x 0.500	61,130	111,410	15	21.50	Ten days later.
2 x 0.798	70,370	121,250	11	14.01	Pulled five days after tire was made.
2 x 0.798	71,980	121,970	14	17.89	Seven days later.
2 x 0.798	65,080	121,470	11.50	13.65	Seven days after tire was made.
2 x 0.798	64,400	121,160	13	16.30	Fourteen days later.

LOCOMOTIVE DESIGN—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer Rogers Locomotive Works.

PARALLEL OR SIDE RODS.

(Concluded from Page 23.)

For resistance to bending the rod should be considered as a column with flat ends. It has hinged or pin-bearing ends, however, against bending in a vertical plane, or in the direction of its depth or greatest side, but when resisting bending horizontally or in the direction of its least width the end bearings are flat.* The strength of a long column depends more upon its resistance to bending than to the crushing strength of the material, and is a function of its elastic rigidity or modulus of elasticity E, the ratio of the length L in inches, the least radius of gyration r, the rigidity function of its cross section, expressed $\frac{L}{r}$, the shape of the end bearings, round, flat or hinged, and the eccentricity of the load. For a straight column, systematically loaded, supported at its gravity axis, so as to be perfectly free to bend, and for a ratio of $\frac{L}{r}$ sufficiently large, Euler's formula will give the strength. This formula is:

$$P = \frac{\pi^2 E}{\left(\frac{l}{r}\right)^2}$$

where P = the ultimate strength of the column in lbs. per square inch.
E = modulus of elasticity in lbs. per square inch.
L = length of column between the pivot bearings, in inches.
r = least radius of gyration of the cross section of the column, in inches.

This is only correct for very long, perfect columns centrally loaded, where $\frac{L}{r}$ exceeds 200 and for pivoted ends. For flat or hinged ends a suitable coefficient should be introduced. The formulae for these conditions may be assumed as follows:

$$\text{For flat ends } P = \frac{25\,E}{\left(\frac{l}{r}\right)^2}$$

$$\text{For hinged ends } P = \frac{16\,E}{\left(\frac{l}{r}\right)^2}$$

The parabolic column formulæ for ordinary lengths, say, of less than a ratio of $\frac{l}{r}$ 200, given by Prof. J. B. Johnson in "Materials of Construction," appear to fit the tests of columns better, and are more suitable for our purpose than any others. The two which will be considered are:

Ultimate strength in pounds per square inch—

For wrought-iron columns, flat ends,

$$\text{For wrought iron columns, flat ends } \left(\frac{l}{r} < 210\right.$$

$$P - 34{,}000 - .43\left(\frac{l}{r}\right)^2$$

$$\text{For mild steel columns, flat ends } \left(\frac{l}{r} < 190\right.$$

$$P = 42{,}000 - .62\left(\frac{l}{r}\right)^2$$

Fig. 6 shows a diagram of the curves derived from these formulæ, also the curve for the Euler formula, adapted to col-

* See Johnson's Materials of Construction and Modern Framed Structures.

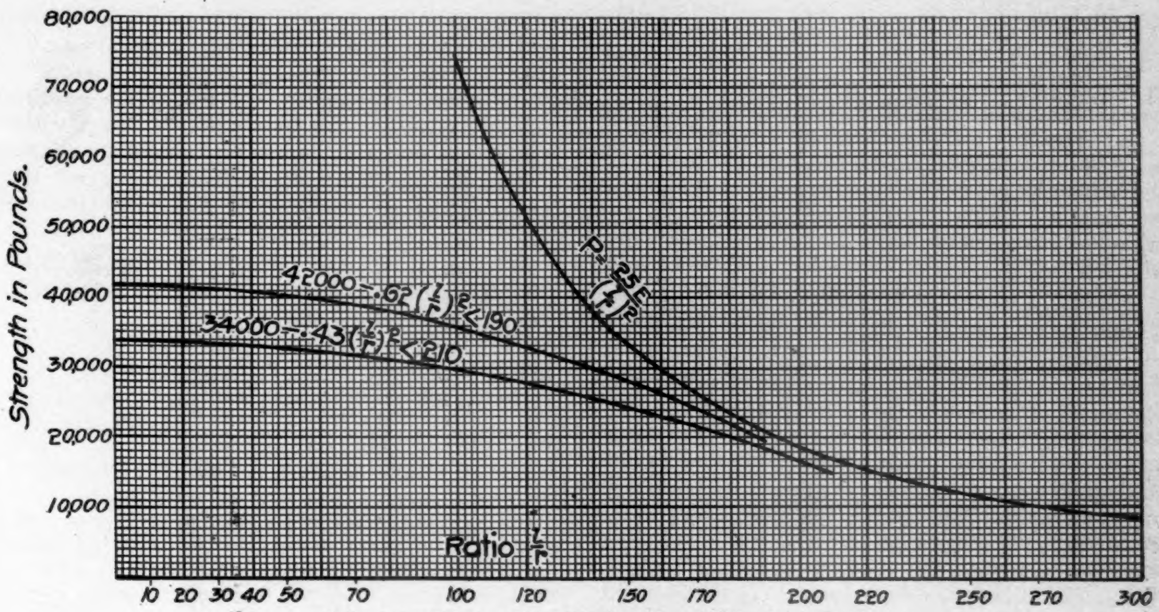
umns with flat ends. This shows graphically why the Euler formula should not be used for columns of ordinary length, which has sometimes been attempted upon the idea that it was applicable to all lengths of columns. For the rod under consideration $\frac{l}{r} = \frac{100}{.598} = 167$. The ultimate destructive pressure per square inch $= P = 42{,}000 - .62 \left(\frac{l}{r}\right)^2 = 24{,}710$ pounds.

The force transmitted through the rod is 25,900, and the sectional area 6.56. The ultimate strength to resist pressure is $24710 \times 6.56 = 162{,}097$ pounds.

It is safe to assume that the maximum stress due to the thrust of the piston, either in tension or compression (the latter force tending to bend or buckle the rod in the direction of its least width), will not occur in combination with the maximum stress due to the centrifugal force. The latter is at zero for bending in a vertical plane, when the piston is at either end of the stroke, gradually increasing until the crank has moved 90 degrees, then decreasing until it becomes zero again at the other end of the cylinder, where it is a force acting directly in line with the axis of the rod.

The indicator diagram, Fig. 7, shows approximately the steam distribution of a locomotive running at 60 or 70 miles per hour, with a 68 to 72-inch diameter driving wheel.

For convenience, the path of the crank is also shown. The steam pressure, it will be observed, only approaches the maximum at the beginning of the stroke, and at half stroke less than 50 per cent. of the boiler pressure. It is practically impossible for the maximum piston thrust to be prolonged until half stroke, when running at high speeds.



Ultimate Strength of Columns With Flat Ends.
Fig. 6.

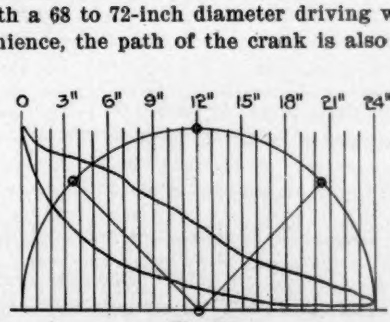


Fig. 7.

With the following conditions: 19x24 inch cylinders, 69 inch diameter driving wheels, American 8-wheel type, 100-inch centers between wheels, 150 pounds boiler pressure and parallel rods of hammered wrought-iron, Fig. 8, section in center 1⅞ by 5 inches, the rods frequently break.

The maximum fiber stress due to the centrifugal force alone at 70 miles per hour (a speed which these engines frequently attain) is:

Revolutions per second, 5.68.

Velocity in feet per second $= 5.68 \times 6.28 = 35.67$.

Weight of rod per foot = 31.25 (ham. iron).

Weight of rod (except ends) $= \frac{31.25 \times 100}{12} = 260$ lbs.

$$F = \frac{260 \times 35.67^2}{32} = 10337$$

$$S = \frac{10337 \times 100}{8 \times 7.81} = 16{,}540 \text{ lbs.}$$

The ultimate strength as a column to resist buckling is as follows: Area 9.38, moment of inertia 2.746 (least side), least radius of gyration .541, ratio $\frac{l}{r} = 185$.

The ultimate strength $= 34{,}000 - .43 \left(\frac{l}{r}\right)^2 = 19{,}275 \times 9.38 = 180{,}800$ lbs. The force transmitted by the rod $= \frac{19^2 .7854 \times 150}{2} = 21{,}225$ lbs.

The I-section rod shown in Fig. 9 has been used for a number of years without any known fractures for high speed 8-wheel American type passenger engines having cylinders 20x 24 inches, material steel, with a tensile strength of from 70,000 to 80,000 lbs., drivers 78-inch diameter, steam pressure 160 lbs., length between centers 90 inches, moment of inertia (axis perpendicular to web) 10.728, section modulus $\frac{I}{0.5h} = 5.364$, weight of section per foot 17 lbs., weight of rod except

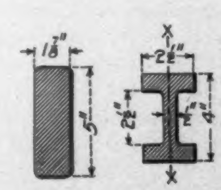


Fig. 8. Fig. 9.

ends $17 \times 7.5 = 127$ lbs. Eighty miles per hour = 5.747 revolutions per second, the velocity per second = $5.747 \times 6.28 = 36.09$, F = 5,162 lbs., S = 10,830 lbs. fiber stress due to centrifugal force. The normal force transmitted through the rod to the rear wheel due to the piston thrust is: $\frac{20^2 \times .7854 \times 160}{2}$ = 25,120 lbs.

Its ultimate strength as a column with flat ends to resist buckling is:

Least radius of gyration = .563. Area of section = 5. $P = 42,000 - .62\left(\frac{l}{r}\right)^2 = 26,130 \times 5 = 130,650$ lbs. Ratio of force transmitted to ultimate strength in compression, $\frac{130,650}{25,120} = 5.2$. And for tension, $\frac{25.120}{5} = 5,025$ stress per square inch, ratio of tensile stress to ultimate $= \frac{75,000}{5,025} = 14.9$. This section is lighter than usual, representing probably the minimum weight and highest stress which should be used for this purpose. As a matter of fact, later engines of this type were built with rods of heavier section, not, however, because they had broken or cracked in service, but owing to their being much lighter and smaller in section than other rods on engines of this size in general use it was feared that they might break, especially as the engines were hauling some of the fastest trains in this country.

Two examples of freight engines with plain rectangular rods of hammered iron are given below. There is nothing peculiar about them; no breakages in the bodies have occurred in seven or eight years; they merely represent average and ordinary conditions. The speed in both cases is taken at 45 miles per hour as a maximum. The conditions for the first are: Consolidation type cylinders, 21x26 in.; steam pressure, 165 lbs.; drivers, 50 in. diameter; piston thrust, 57,090 lbs.; force transmitted by back section of rod $= \frac{57,090}{4} = 14,270$ lbs.; sectional area, $1\frac{3}{4}$x 4 in. plain rectangular; weight per foot, 23.8 lbs.; weight of rod (exclusive of ends) =

$$\frac{23.8 \times 61.5}{12} = 122 \text{ lbs.}$$

area 7 square in.; modulus of section, 4.67; length in in., $61\frac{1}{2}$; least radius of gyration, .505; ratio $\frac{l}{r} = 122$; ultimate strength to resist bucking:

$$34,000 - .43\left(\frac{l}{r}\right)^2 = 27,500 \text{ lbs.} \times 7 = 192,500.$$

Stress due to centrifugal force:

Velocity in feet per sec. = 34.3

$$F = \frac{34.3^2 \times 122}{1.083 \times 32} = 4,136 \text{ lbs.}$$

$$S = \frac{4136 \times 61.5}{8 \times 4.67} = 6,808 \text{ lbs.}$$

The conditions for the second type are: Ten-wheeler; cylinders, 19x26 in.; steam pressure, 165 lbs.; piston thrust, 46,695; force transmitted through the back section of rod, 15,565 lbs.; section, $1\frac{3}{4}$x4 in., plain rectangular area, 7 square in.; length, 75 in.; drivers, 50 in. diameter; ratio, $\frac{l}{r} = 148$; ultimate strength to resist bucking:

$$34,000 - .43\left(\frac{l}{r}\right)^2 = 24,582 \times 7 = 172,074 \text{ lbs.}$$

Stress due to centrifugal force:

Velocity in feet per sec. = 34.3

$$F = \frac{34.3^2 \times 149}{32} = 5,478 \text{ lbs.}$$

$$S = \frac{5,478 \times 75}{8 \times 4.67} = 10,990 \text{ lbs.}$$

CONCLUSIONS.

The conclusions are briefly summarized as follows:

The extreme fiber stress in long rods caused by centrifugal force can be safely taken at 11,000 lbs. for steel and 9,000 lbs. for wrought iron per square inch.

The stress due to the direct push and pull of the piston should not exceed 5,000 lbs. per square inch for steel and 4,000 lbs. for wrought iron. This refers more particularly to I sections, as the plain rectangular sections have areas so much larger that the stresses due to the centrifugal force and buckling as a column become the limiting factors.

The ultimate resistance to buckling should not be less than five times the normal working load transmitted through the rod; that is, if the force conveyed by the rod is 30,000 lbs. it should be so proportioned that it would not fail by bending or buckling at less than 150,000 lbs.

THE SOUTH UNION STATION, BOSTON.

In our February, 1897, issue, we gave an account of a projected terminal station for roads entering Boston on the south side, together with a perspective view of the structure, and a general plan of the track and loop scheme as they would appear when completed. After the lapse of nearly two years this handsome terminal is now ready and open for business. It was opened on the first of January to the Old Colony and the New England trains only, as the Boston & Providence and the Boston & Albany have not yet made the necessary track connections.

This terminal station, the largest in the world, is bounded on three sides by Cove street, Federal street, Sumner street and Dorchester avenue. It is on ground once occupied by the New England station. Opposite the end of Federal street is situated the main entrance. The building extends from this entrance south 792 feet, and east on Sumner street 672 feet. As seen from Federal street, the central part of the building is a five-story structure, the first story of which is devoted to station purposes, and the remainder to office uses. In the central curved part, 228 feet long, two stories high, there are three grand entrance arches, the upper stories forming a colonnade, the columns of which are 52 inches in diameter and 42 feet high. Above the colonnade the entablature and parapet, broken by the small projecting pediment, carry the facade to a height of 105 feet from the sidewalk. Above all, and at the center, is the clock, with a dial of 12 feet in diameter, which is surmounted by an eagle. All of the curved portion of the front is built of Stony Creek granite, and nearly all of the remaining portion is of the same stone, but on each side of the colonnade the stone work is relieved by large, dark-buff mottled bricks.

The total length of the five-story front is 875 feet; that of the two-story portion, along Atlantic avenue, 356 feet; of the two-story part on Sumner street, 234 feet. On Dorchester avenue the building continues 725 feet, two stories high. The total frontage on three streets is 2,190 feet. Entering at the main entrance, there are no steps to surmount, but a clear passage way, with an easy rise of about 3 feet in 100, leading into the great midway, lying across the ends of the stub tracks. Near the center of the midway are stairways leading to the lower floors, and at convenient locations are the newspaper and fruit booths. Opening from the midway at the right is the parcel room. At the left are the lavatories, telegraph and telephone offices, and a ticket office with 11 sales windows toward the midway, besides 16 openings into the waiting room.

The waiting room has a width of 65 feet, length of 225 feet, and height of $28\frac{1}{2}$ feet. The women's room is located off from a corner of the waiting room, and is 34x44 feet, elegantly furnished with rockers, easy chairs and lounges. At the corner of the lunch room is the stairs and elevator to the dining room, on the second floor. The floors above the first story are used for offices and employees. Conductors and trainmen have quarters on the Dorchester avenue side, and the remainder of the second story is devoted to the use of the Boston Terminal Company. The entire third story is occupied by the offices of the Boston &

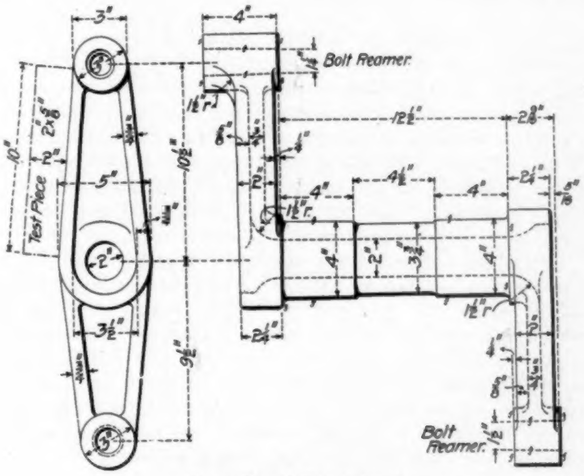
Albany, and the fourth and fifth stories are assigned to the New York, New Haven and Hartford Railroad.

The power plant contains 10 large boilers, two economizers and 1,500 horse-power of Westinghouse compound engines, driving four Westinghouse multipolar dynamos, which are direct connected, while the total horse-power is about 2,000, with ample provision in space for a possible increase of about 50 per cent. The description of the station plans, previously referred to, give further details of this magnificent piece of work.

CAST STEEL ROCKER SHAFT.

By the courtesy of Mr. E. E. Davis, Assistant Superintendent of Motive Power of the Philadelphia & Reading Railway, we illustrate one of the patterns of cast steel rock shafts now used on that road. In this shaft, which was designed by Mr. H. H. Vaughn while mechanical engineer of the road, an attempt has been made to distribute the metal so as to effect the greatest possible economy in material, an object of importance when it costs 4 cents per pound, and also to avoid any variation in the thickness of the casting likely to introduce local weakness. Lightness and strength are evident in the coring of the body and form of the arms which are of I-section.

The cast steel shaft requires very little labor in the machine shop, the only finish on it being at the ends of the bearing, at



Cast Steel Rockers.
Philadelphia & Reading Ry.

the pin holes and the faces of the pin bases. Owing to its lightness, the cost of material is even less than for a wrought iron shaft for the same duty. The costs per pair being as follows:

Cast steel shafts:	
Material, at 4.5c.	$7.46
Machine shop, labor	3.26
Total	$10.72

These figures are based on actual casts, not estimated in any particular, and so far the test of service has shown the steel shaft to be perfectly satisfactory.

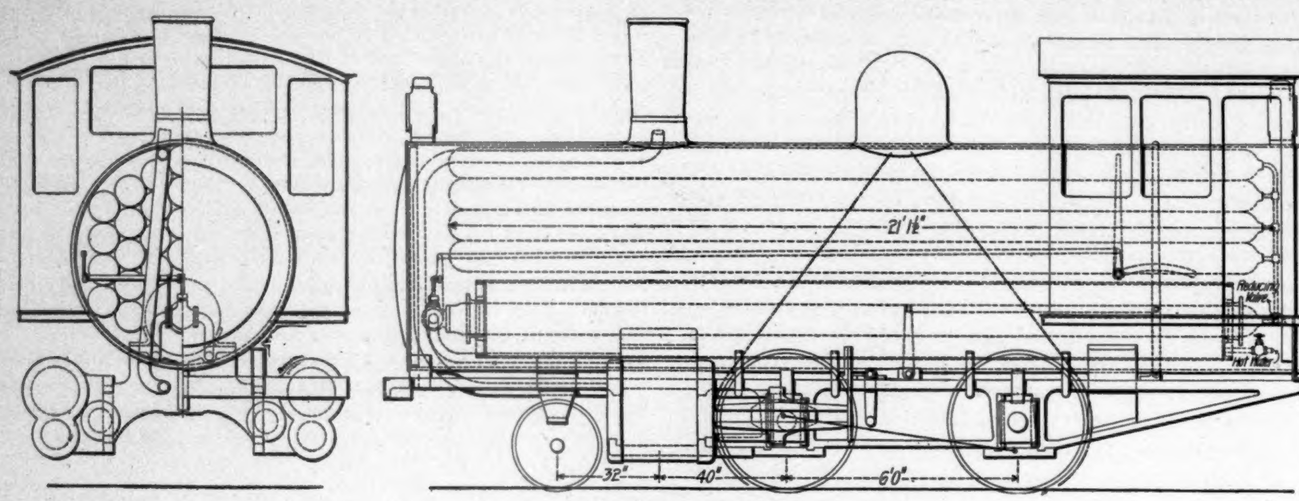
SIR W. H. WHITE ON ENGINEERING EDUCATION.

A meeting of the Institution of Junior Engineers, held in London in October, was addressed by the President-elect, Sir W. H. White, Assistant Controller of the Navy and Director of Naval Construction, on the subject of an engineering education. Among other things, he said the past century had witnessed a wonderful growth and development of civil engineering. Scientific method was becoming more and more established in engineering practice and in experimental research. There was no exclusion of engineers from the ranks of scientific men. And there were numerous instances of men distinguished no less as men of science than as engineers.

Having enforced the importance of "communion and fellowship" between all branches of engineering, he desired to record his equally strong conviction that for the "average man" an early specialization of practice was advantageous and generally led to greater success. Probably for many of the members of the institution there had been no alternative, and it had been necessary to undertake work in some department of engineering at an early period. Provided the preliminary education had been satisfactory there was not, in his judgment, any reason for regret if that necessity had arisen. It had been his fortune to be constantly asked what course of training he would recommend for youths intended to become engineers. His advice had always been the same, and it was based on personal experience and extensive observation. Practical training in the workshop, factory, ship yard or other engineering establishment was, he considered best begun when a lad was fresh from school. "Roughing it" then came easy, observation was quick, while the facility for acquiring handicrafts and manual dexterity was greatest. Familiarity with the habits and modes of thought of workmen was readily gained also, and was a valuable acquisition. During the period of practical training it was most desirable that scholastic knowledge should be maintained or extended. Unfortunately, this was often neglected, and the loss was serious. In many cases arrangements could be made by which boys need not be subjected to such extreme physical exertion as would prevent evening study, and in all great industrial centres suitable evening classes were now established in which instruction could be obtained. If this programme were carried out, a young man finished his practical course without loss of educational knowledge, and if he had the means and capacity he was well prepared for entry into a technical college at an age which permitted him to obtain the full benefit of theoretical training and laboratory work. With ability and energy commensurate to the task a student thus prepared, and bringing with him considerable practical experience, ought to reap the greatest advantage from the higher course of study, and to be ready for actual work when it was completed. His observation and experience as student and professor convinced him that many youths entered technical colleges who, from want of preliminary education or of ability, could never hope to benefit much, if at all. It would be a kindness in such cases if entry were guarded by such preliminary tests and inquiries as would prevent waste of time and permit other and more suitable training to be undergone. Perhaps the ideal system of training was that which permitted an engineering pupil to continue his scholastic training side by side with the preliminary practical experience, as the medical student attached to a hospital did. Selected men, having proved their capacity, could then proceed to a course of higher technical training without losing all contact with practical work. The latter condition could be met by arranging suitable intervals when students would suspend their studies of theory and go out to the scenes of engineering operations, where they could compare the lessons learned in the study and laboratory with actual procedure in carrying on work. Opinions differed widely respecting the system of "premium apprentices." He had his own opinion, but would not express it. On one point there would probably be general agreement. It would be a distinct advantage if young men of that class, who as a rule had the necessary preliminary education and possessed the means, could combine theoretical training with their period of employment in the office, workshop or ship yard. This would apear to be quite feasible and unobjectionable. While he was convinced of the desirability for most men to decide early on the kind of engineering work they desired to do, and thoroughly to qualify for its performance on both the scientific and practical sides, he was aware that many authorities took a different view. Nor did he suppose that there were not exceptions to the rule he suggested. It was intended for the average man, and not for the genius, who was outside all rules. Most of them could lay no claim to genius; and before long they learned to recognize their limitations. They could, however, all display that form of genius which consisted in the capacity for taking pains and doing their best. Educational facilities were fortunately more ample than they had ever been, as well as more within the reach of modest means. No one could now complain of lack of opportunity for perfecting his equipment as an engineer. The existence of that institution was an evidence of the changed conditions under which engineering work had to be done. Its educational influence was doubtless considerable. Let them hope that it might long continue to flourish and be increasingly useful to junior engineers.

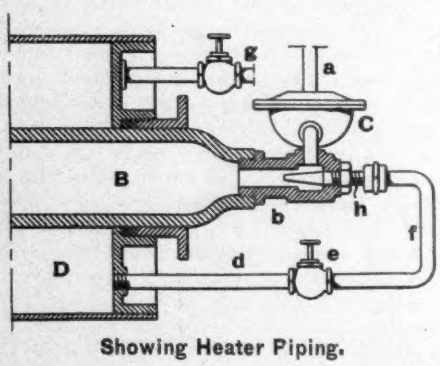
VAUCLAIN'S COMPRESSED AIR LOCOMOTIVES WITH HEATER.

The Baldwin Locomotive Works, in June, 1897, built a compound four-coupled compressed-air locomotive, of the mining type, for the Philadelphia & Reading Coal & Iron Company for use in their Alaska Colliery, and its success led to the ordering of three more of the same kind. This firm is prepared to build compressed-air locomotives, either single expansion or compound, to suit any requirement of service for which compressed air is suitable, and a recent improvement in design in the form of a heater has been developed and patented by Mr. S. M. Vauclain, although this has not yet been applied to an actual locomotive.



Vauclain's Compressed Air Locomotive.

This is shown in the engravings as applied to a locomotive having its storage tanks in the form of tubes. These tubes



Showing Heater Piping.

are connected by pipes at the back end and to an auxiliary reservoir B by the pipe A. The air for the cylinders is taken from the front end of the reservoir B. The reservoir is surrounded by a hot-water drum D, which is filled through the pipe G. The pipe D connects with a nozzle H to inject a spray of hot water into the reservoir B to assist in heating the air and to lubricate the cylinders. A reducing valve C is placed in the pipe connection between the storage reservoir and the auxiliary reservoir B.

THE MASTER MECHANICS' STAYBOLT COMMITTEE.

If the committee, comprising Messrs. Lawes, Vauclain and Wilson, on the best method of applying staybolts in locomotive boilers receives answers to their circular of inquiry as painstaking and thorough in their scope as are the questions formulated, they will have information that will furnish the groundwork for one of the most valuable documents ever presented to the association. They have covered the staybolt matter most completely in a series of 18 questions, which embrace every kind and stage of manipulation, from the rough bar to the finished bolt and its manner of application, together with the way in which the holes are prepared to receive the bolts. With special reference to fit alone there are two clauses in this circular that it is hoped will have the attention their importance demands. First, "Do you consider a lead screw attachment to a staybolt screw-cutting machine essential in producing good staybolts?" The object of this question is evidently to determine the relative value of this refinement in screw cutting as practiced on staybolts, over the old and more crude output of the ordinary dies. We believe there cannot be two opinions in this matter, since a true and constant pitch of thread is an imperative requirement in avoiding initial stress on bolts or sheets. Having a direct bearing on this phase of the subject is another which reads: "Have you any special kind of taps for tapping staybolt holes?" What are the advantages of such taps as compared with the usual form of tap?

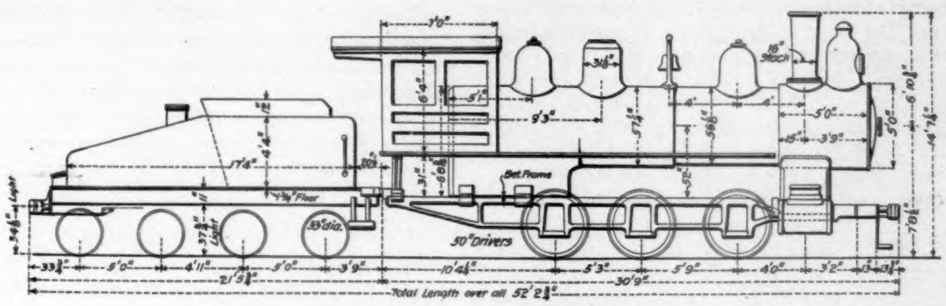
A very close relation (that should, but does not often, exist) between a staybolt tap and the finished bolt is one of the things too often taken for granted, with the result of producing a stress on the bolt before performing its office. This is brought about by variation in pitch of the thread, and a bolt when applied under these circumstances must be made small and thus sacrifice the fit, in order to pass through both sheets. The importance of attention to the accuracy of pitch is as vital to success in one case as the other, and harmony in this particular between staybolts and their taps, we think is one of the essentials to good staybolt work. The error in pitch of threads cut by the Jones & Lamson system is reduced to working limits and is practically constant, while that existing in taps comes from two sources, one from lead screw error on the lathe cutting the thread, and the other from shrinkage due to hardening. If the former error is plus, it will tend to neutralize the latter, but if minus then they become cumulative and the tap is unfit to use. These errors of pitch are not as well recognized as they should be, and we believe on this account the staybolt question would be simplified greatly by an earnest effort looking to their elimination in all railroad shops, as we know it to be done in the shrinkage of the tap, and thus have it of correct pitch as in the Northern Pacific shops at Brainard, Minn. In this case, all errors of lead screw are overcome by means of an auxiliary device on the lathe threading a tap, by which the carriage and with it the thread tool are retarded or accelerated uniformly over the threaded portion, and by its use the thread may therefore be cut so as to be sufficiently short to overcome the shrinkage of the tap and thus have the pitch more nearly correct after hardening.

Ship draftsmen are wanted for a number of government positions at various places and civil service examinations will be held February 7, 8, 9 and 10. Examinations will be held in every city where the civil service commission has a Board of Examiners. Applicants must write or telegraph the Commission at Washington, D. C., in time for shipment of examination papers. Applicants must be 20 years of age or over.

NEW SWITCHING LOCOMOTIVES.

Chicago, Milwaukee & St. Paul Railway.

The accompanying engraving illustrates the design of new switching locomotives recently built by the Chicago, Milwaukee & St. Paul Railway. These engines are known as Class F. They weigh 103,000 pounds on drivers and the total weight in working order is 158,000 pounds, the weight of the tender being 55,000 pounds. The firebox is on top of the frames and the boiler is high, giving the enginemen the advantage of elevated positions for watching their work. The following are the chief dimensions of the engines:



New Switching Locomotive—C., M. & St. P. Ry.

Boiler pressure	180 pounds
" material	9-10 inch steel
Firebox "	½-inch steel
" length of	6 feet 6 inches
" width of	3 feet 5 inches
" depth of	5 feet 2⅝ inches
Staying	**radial**
Flues	2-inch, 12 feet 10 inches long; number, 178
Heating surface, flues	**1,180 square feet**
" " **firebox**	**132 square feet**
" " **total**	**1,312 square feet**
Grate area	22 square feet
Steam ports	17½ by 1¼ inches
Exhaust "	17½ by 2½ inches
Bridge	1½ inches
Value travel	**5½ inches**
" outside lap	¾ inch
" inside "	1-32 inch
Valve, mid-gear travel	2 7-16 inches
" cut-off, full gear	22 inches
Link radius	**2 feet 10¾ inches**
Cylinders, size of	18 x 24 inches
Driving journals	**7½ by 11¼ inches**
Crank pin, front	4 by 3½ inches
" " main	5 by 4¾ inches
" " rear	4 by 3½ inches
Crosshead pin	3 by 3 inches
Capacity of tank for water	**2,900 gallons**
" " tender for coal	4 tons

STUPAKOFF'S COMPAROMETER.

This is an instrument for the comparison and determination of standard dimensions, numbers of standard gauges, and various correlative properties of objects depending on their dimensions. It is made of tool steel, with the working edges hardened and ground, and contains a micrometer caliper, of English and metric divisions, with various current gauges for wire, plate drills, etc., and gives the weights for round and sheet metals, the number of threads per inch for standard machine screws, and suitable tap drills therefor, besides furnishing the means for comparing any or all of these data with the least possible liability of error.

The mechanical principle involved in the instrument is that of a plane spiral base, combined with a radius vector, movable around its pole. Any movement of this radius vector causes some fixed point on it to recede from or advance toward the spiral. The rate of such recession or advancement is in direct proportion to the arc traversed, and this holds for regular Archimidean spirals of any pitch. The metric circle gives direct readings from zero to 12.7 millimeters, in hundredths of a millimeter, and divisions on the inside of the smallest circle gives relative values in sixty-fourths of an inch.

The comparometer is intended as a time saver in the transposition of values from a given base, its scope being plainly conveyed in the name, "New Universal Gauge and Spirametric Micrometer." The pamphlet describing its uses is issued by the Vulcan Manufacturing Company, Limited, Pittsburg, Pa.

INSPECTION OF WATCHES.

It seems to have been the practice for employees of the Illinois Central to have their watches regulated by others than the inspectors employed by the company for that service, a procedure likely to lead to complications if permitted to continue, and this has brought out a circular from General Superintendent Sullivan in which he said: "As any standard watch purchased from an authorized inspector, which fails to run within a variation of thirty seconds a week, will be redeemed by the inspector, also by the manufacturer, without expense to the owner, there is no object to be gained in attempting to evade the inspection requirements. Any employee having a watch whose performance is inferior to the standard required, and who attempts by unauthorized regulation to impose upon the inspectors, practices a deception upon the management of the road; it is, therefore, required that hereafter conductors and other trainmen, engineers and firemen shall not attempt to regulate their watches themselves, nor permit them to be regulated by any other person than the authorized inspectors. Failure to comply with these requirements will be considered cause for dismissal from the service."

The Atchison, Topeka and Santa Fe have just taken up a new system of watch inspection, and placed a rule in effect January 1 which provides for a weekly record of all watches within the jurisdiction of the watch inspector. A quarterly inspection has been substituted for the monthly inspection, and trainmen will still be required to sign the daily register. Cards for watch records bearing the name, occupation and address of the owner of the watch, and the name of the movement and the number, have been issued to those interested. On these cards the number of seconds fast or slow, showing the rate at which the watch runs, is recorded, and when the watch is set or regulated by the inspector an entry to that effect is made by him. Once a week a local inspector notes the condition of the watch with reference to accuracy. The cards are sent to the trainmaster on the first of each month.

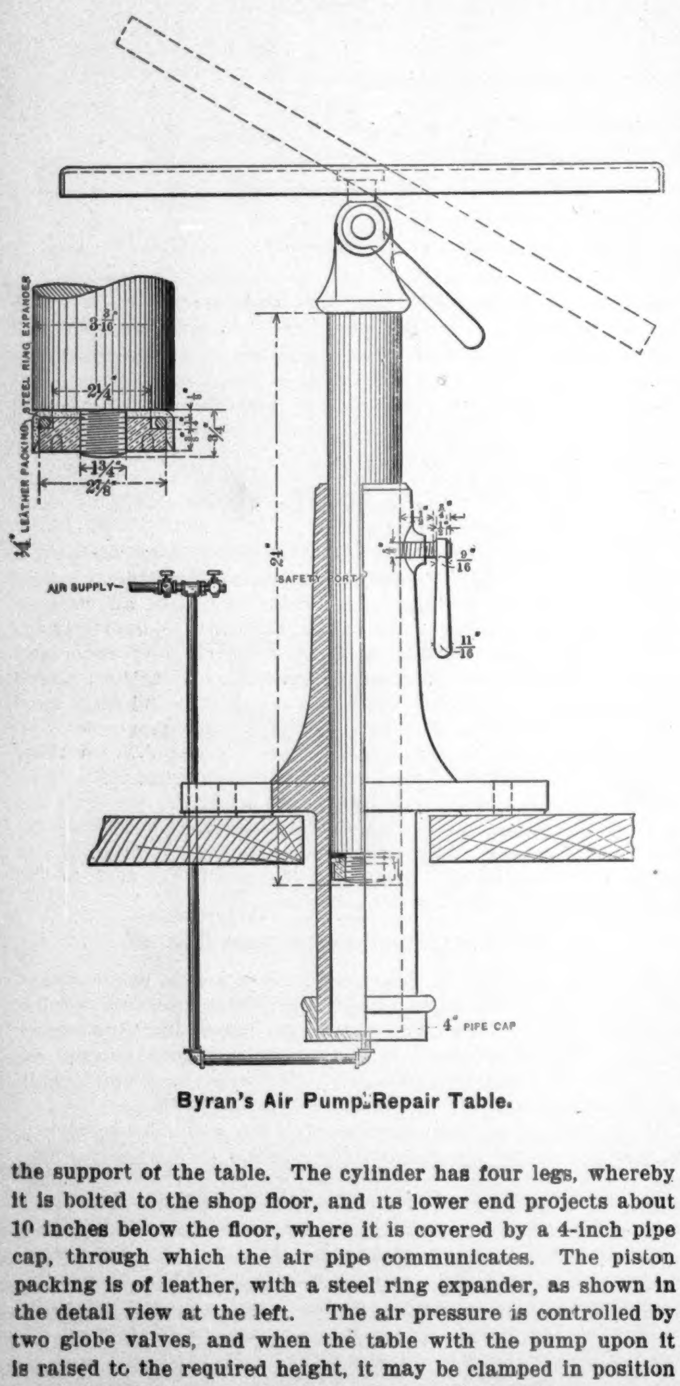
J. PIERPONT MORGAN'S NEW YACHT.

The "Corsair," Mr. J. Pierpont Morgan's new steam yacht and the third of that name to be built for him, was successfully launched at Newburg, New York, December 12. This vessel replaces the "Gloucester" that gave such a good account of himself before Santiago. She was sold to the Government and refitted as an auxiliary during the war with Spain.

The "Corsair" is built entirely of steel, with plates worked in flush above the water line. Her interior arrangements consist of ten staterooms, a library, six bathrooms and a dining saloon on the lower deck. On the main deck, arrangements have been made for a deck saloon, galley, chartroom and deck stateroom with officers' and crew's quarters forward, while the boxes, storerooms, &c., are arranged in the forward hold. Her principal dimensions as designed by Webb are: 302 feet over all, 252 feet on the water line, 33 feet 3 inches extreme beam, 20 feet 6 inches depth of hold, and 14 feet 6 inches draught. She will be equipped with two triple expansion engines, and steam will be furnished by two double-end Scotch boilers. The craft will also have a complete electric plant in duplicate for lighting and other purposes. She will carry three launches, one lifeboat, one gig and one cutter on davits. The Fletchers of Hoboken will build the machinery. Her deckhouses are of galvanized iron and will be covered inside and out with mahogany trimmings, and waterways and rails of teak.

AIR PUMP REPAIR TABLE WITH PNEUMATIC LIFT.

The weight of an air brake pump is such as to render it an awkward piece of work to handle in the shop by one man, and the novel device shown in this engraving was designed and built by Mr. H. S. Bryan, Master Mechanic of the Duluth & Iron Range Railroad, for the purpose of saving expense and labor in refitting and repairing. The pump is bolted to a flat cast-iron table, 19x26 inches in size, by means of two 3⅛x9-inch slots cored through it. The table is held on trunnions, on which it may be tipped to any desired angle, and held there by the set screw. The trunnions are carried on a fork, which is forged on the top end of a piston rod, 3 3-16-inches diameter by 24 inches long, fitting in a pneumatic cylinder that forms



Byran's Air Pump Repair Table.

the support of the table. The cylinder has four legs, whereby it is bolted to the shop floor, and its lower end projects about 10 inches below the floor, where it is covered by a 4-inch pipe cap, through which the air pipe communicates. The piston packing is of leather, with a steel ring expander, as shown in the detail view at the left. The air pressure is controlled by two globe valves, and when the table with the pump upon it is raised to the required height, it may be clamped in position by means of the set screw, shown at the right. Safety ports are drilled near the top of the cylinder to prevent raising the piston too high. The table may be tipped into a vertical position, because of the offset of the trunnions below the level of the table. We are indebted to Mr. Bryan for the drawing, and he states that the device is not patented.

THE FIREPROOFING OF WOOD.

That everything on board ship that is not necessarily combustible can be made fireproof, is the opinion of C. J. Hexamer, Ph. D., expressed in an interesting paper read before the Franklin Institute, Nov. 16. The author had given the subject a great deal of study since 1882, and he now recommended a process, using water glass, and said: "I might state that for ordinary purposes a block of wood can be made fire resisting by repeatedly soaking it in a water glass solution, and, when dry, coating it with a mixture of the liquid and cement."

The fireproofing process was to use only well seasoned, thoroughly kiln dried lumber, and to impregnate, if possible, only the finished articles. The wood is placed in a strong metal chamber, closed hermetically, and jacketed with steam, but no steam should be allowed inside the chamber. The moisture is driven out by long continued heating at a little above the boiling point of water. The next step is to exhaust the air, and when the air has been removed from the wood a solution of water glass is sprayed upon the wood. Then a pressure of about 10 atmospheres is applied and kept up for 3 hours, to drive the water glass into the wood. Success depends largely upon the thoroughness of removal of the moisture, sap and air from the wood before impregnation.

Insoluble silica is then precipitated in the wood from the water glass by a solution of ammonium chloride, a very cheap substance, which gave excellent results. It produces in the very fibers of the wood "a gelatinous precipitate of silica; salt, which is readily removed from parts near the surface by soaking in water, tending to preserve the wood in the interior; and ammonia gas, which goes off of itself."

By using strong solutions the process gave specimens of petrifaction. The author says:

"It will probably be urged that my process is expensive; but in a case like this expense is not a factor. We cannot afford to take the risk of not having everything possible about a man-of-war—or, for that matter, of any ship—fire-proof, when upon that fact may depend a victory or a defeat of our navy. Nor is the expense as great as it at first appears; for the Government should attend to this work itself, and not leave it to contractors. In point of fact, I believe it will be found that the only considerable outlay necessary would be the first cost of the large air-tight receptacles."

ECONOMICAL FORGING FURNACES.

A report to the Master Blacksmith's Association by a committee of which Mr. D. Uren was chairman, contains recommendations for constructing reverberatory furnaces, with a view of economical use of fuel, and the recommendation with regard to complete combustion and the admission of air over the fire is applicable to many other kinds of furnaces, particularly the fireboxes of locomotives. The recommendations, in part, follow:

"We recommend a furnace for general use of sufficient capacity to receive 10 or 12 160-pound or 200-pound piles of scrap iron with two doors properly swung for convenience in opening; furnace hearth to be 4 feet wide, 7 feet 6 inches long, inclined from the bridge wall to the entrance of the flue 4 inches, for the purpose of giving easy flow of the slag to the slag outlet; bridge wall about 14 inches high from the hearth; 25 inches between hearth and roof; combustion chamber 4 x 3 feet; grate bars about 10 inches below the hearth. This gives an area of 1,728 square inches. The furnace is operated with a forced blast under the grate bars. For the purpose of producing more perfect combustion an auxiliary blast pipe is placed across the front end of the furnace. From this pipe branch pipes 1 inch in diameter leading into the combustion chamber, so as to permit the air to pass in half way between the bridge wall and roof, are distributed the full length of the cross-section of the furnace.

"The main pipe is provided with valves, and, if judiciously operated, will greatly assist in producing more perfect combustion. Particularly when the furnace is charged with new coal it requires more oxygen to produce perfect combustion than after the gases have been partially liberated from the coal, consequently this blast should be partly closed after most of the smoke has been consumed.

"The furnace above described is sufficient for all requirements in the ordinary railroad shop.

"This furnace will not be economical regarding fuel for small work, but these are conditions that cannot be avoided. In many cases the heat of the furnaces can be utilized for forming small work after the day's work of forging or scrapping is done. By this means it can be made economical for small work. In furnaces that are constructed for special purposes, such as axle-making or heating for the rolling mill, the proportions as described above should be carried out regarding the hearth and combustion chamber, grate area, etc."

ENLARGED WHEEL FITS FOR DRIVING AXLES.

We have had occasion in recent issues to notice improvements in the design of locomotive details, and prominent among these were crank pins and axles, two parts that invite trouble when made too light for their work. The practice in this country until very recently has been to follow so closely the proportion of these parts as used in lighter engines that attention to the present requirements of heavy ones in this direction is a gratifying evidence of an awakening to the needs of the situation. That average American practice in the matter of strength of these details is not equal to that of foreign roads was shown on page 19 of our January issue in the table compiled by Mr. L. R. Pomeroy.

By courtesy of Mr. J. E. Sague, Mechanical Engineer of the Schenectady Locomotive Works, we show in Figure 1 the improved method of fitting driving axles to wheels. This axle has an enlarged wheel fit and a collar ¼ inch in length and ⅛ inch larger in diameter than the wheel fit, the collar having a fillet of ⅜ inch radius on the wheel fit side. This collar is found advantageous in preventing any tendency of the wheel to move

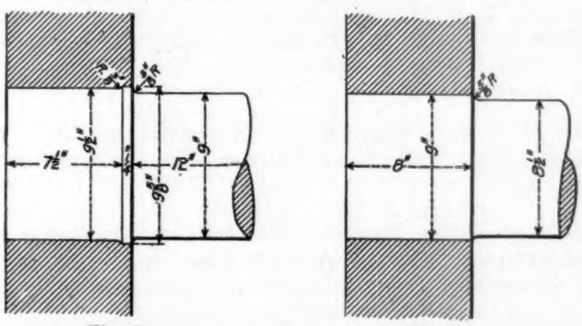


Fig. 1. Fig. 2.

Enlarged Wheel Fits for Driving Axles:

on the axle when entering sharp curves, a tendency which is caused on plain axles by the centrifugal force due to high speeds, in spite of the common pressures used in forcing a wheel to place. Figure 2 is another axle having the reinforcement idea well shown. This axle represents the practice on the Chicago & Northwestern Railway. In both of these examples it is seen that the enlarged wheel fit practically eliminates the danger of fracture at the hub, a danger ever present with the reduced wheel fit, and specially aggravated by the removal of stock at the shoulder to form the key seat. The latter trouble has, however, been partially overcome by tapering the key way so as to run easily into the shoulder, which is found to be satisfactory in the case of the shoudered axle, and should be particularly so with those having enlarged ends. The amount of enlargement of the wheel fit is ½ inch, which is considered sufficient in view of the fact that the journals will be kept in service until they are worn down about ½ inch smaller in diameter than they were originally, and therefore the difference in diameter is increased by wear.

BRIEF HISTORY OF THE BALTIMORE & OHIO.

The chronology of the Baltimore & Ohio Railroad is interesting at this time, as it will not be many months before it will cease to be operated under the original charter. The first general meeting of citizens, contemplating the building of a railroad to the Ohio River, was held in Baltimore on February 12, 1827. The other important events occurred as follows:

Act of incorporation granted by Maryland, February 28, 1827.

Act of incorporation confirmed by Virginia, March 8, 1827.

Requisite amount of stock for organization subscribed by Aphil 1, 1827.

Company organized; directors elected, April 23, 1827.

Preliminary surveys begun, July 2, 1827.

Actual surveys begun, November 20, 1827.

Charter confirmed by the State of Pennsylvania, February 22, 1828.

Maryland became a stockholder, March 6, 1828.

Cornerstone laid, July 4, 1828.

Railroad opened to Ellicott's Mills, 14 miles (horse-power), May 22, 1830.

Trial of the first steam locomotive on the Baltimore & Ohio Railroad, August 25, 1830.

Railroad opened to:

Ellicott's Mills, 14 miles (steam power), August 30, 1830.

Frederick, 61 miles, December 1, 1831.

Point of Rocks, 69 miles, April 1, 1832.

Harper's Ferry, 81 miles, December 1, 1832.

Hancock, 123 miles, June 1, 1842.

Cumberland, 170 miles, November 5, 1842.

Piedmont, 206 miles, July 21, 1851.

Fairmont, 392 miles, June 22, 1852.

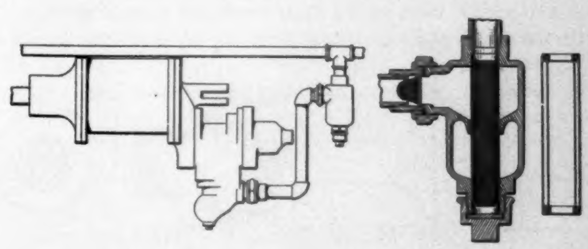
Last spike driven; finished, Baltimore to Wheeling, 379 miles, December 24, 1852.

First train reached Wheeling from Baltimore, January 1, 1853.

Railroad opened, Baltimore to Wheeling, 379 miles, January 10, 1853.

AIR BRAKE DRAIN CUP AND STRAINER.

Our illustration shows a drain cup and strainer gotten up by Mr. Thos. B. Hunt, of Chicago, Ill. The object of this strainer is to do away with the difficulties in cleaning, as en-



Air Brake Drain Cup and Strainer.

countered in some other types, and to provide a simple and durable device that will be reliable at all times. This is accomplished by connecting with the main air brake pipe a drain cup connected to a vertical branch pipe or T-coupling. The cup is provided with a removable screwed cup or plug at its lower end, and the strainer being removably mounted in the drain cup and held in place by the cap, by simply unscrewing the cap, the drain cup itself may be cleaned and the strainer also may be slipped out of the cup, and quickly cleaned and replaced.

CRUSHED STEEL ABRASIVE.

Diamond Steel Emery is an abrasive used in place of emery. The results obtained with it in the Topeka shops of the Atchison road were mentioned on page 13 of our January issue, in which it was stated that this material does not crush or pulverize, and, besides cutting more rapidly than emery, there is less waste. A steam pipe joint is ground very quickly with an amount of this abrasive that may be held on a five-cent piece. We have just received a set of samples of the "steel emery," designated by number, and from its sharpness and uniformity the reason for the rapidity of cutting is clear. Samples may be obtained from the Pittsburg Crushed Steel Company, Limited, Pittsburg, Pa.

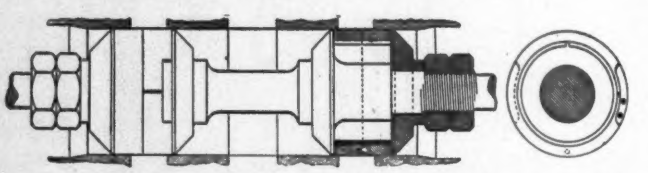
SAFETY DEVICES FOR CAR DOORS.

The facility with which entrance may be effected to the ordinary car loaded with merchandise, leaving the seal intact, without outward evidence of molestation, has led to careful design of safety appliances to cover such cases. Among the best of the most recent efforts to this end are those of the Chicago Grain Door Company, which makes a specialty of the most approved devices for car doors. Their side door bracket, the "Security," is possessed of a vital and interesting feature that is believed will resist the efforts of the most expert crook. The bracket is secured to the sill by a lag screw in addition to the usual bolt through the flange. The lag screw has a total length greater than the width of the bracket from sill to lug, and it can only be introduced by entering the flange diagonally in starting, and this is made possible by coring the hole with a flare on the inner face of the bracket. When the screw is in place, the head is covered by the door, and therefore cannot be reached for removal. This company has also perfected its grain door attachments, and brought them to a simple form. The improvement is in the means of connecting the doors to the vertical rods, and consists of a bracket on the inner face of the door, having an eye-bolt engaging with the rod and free to swivel in the bracket. The advantage of this attachment is in greater freedom from binding when lifting the door—under any reasonable lack of alignment.

A PISTON VALVE USED 65 YEARS.

The accompanying engraving is reproduced from an illustrated description of an interesting old engine by C. E. Wolff, in the "Mechanical Engineer." This engine is used on the Midland Railway, at Swannington, England, for drawing trucks up an incline on a colliery branch.

The engine, which was set to work in 1833, is still used once a week, and is chiefly remarkable for being fitted with a piston valve, of which we give an illustration. As will be seen, the valve is of an ordinary type, each end being fitted with two gun-metal rings, kept up to their work by a steel spring. During the 65 years the valve has been at work it has only twice



An Old and Successful Piston Valve.

been removed for examination. On both occasions it was found to be in perfectly good condition, and was replaced without being touched, and is still working with the original rings.

The shaft consists of a square forging left rough, except for the journals, the fly-wheel being fixed on the square. There is no reversing gear, as the trucks run down the incline by gravity, drawing back the rope. We are not told how often the engine was used during its early life, and we do not know the steam pressure or the amount of work done. The engine is in good condition, and that fact, together with the life of the packing rings, is interesting. The valve is also light in weight and the construction may be suggestive.

The Morgan Engineering Co. of Alliance, Ohio, have found it to be to the advantage of themselves and their customers to sell the product of their works direct, and have terminated the arrangement with the Niles Tool Works Co. Correspondence should be addressed to the home office, Alliance, O., where an able corps of representatives are ready to give immediate attention to all communications.

The tendency to luxury in ornamentation and fittings of sleeping cars has reached a climax in the new cars of the Lehigh Valley in the train service between New York and Chicago. These cars are the latest and finest production of the Pullman shops, and said by that company to be superior to anything yet turned out at those shops. There are several points of excellence about the cars that will make them specially popular with the traveling public, among which is a very large ladies' room provided with a dresser and toilet conveniences heretofore found only in the best appointed homes. The cars are 78 ft. long over platforms, and of course have all modern accessories, such as wide vestibules, safety steam heat, Pintsch light, etc. The finish inside is of vermilion wood from the East Indies, with handsome inlaid marquetry. The seats are upholstered in Persian design with green border and center pattern in bright colors, which was specially imported for these cars. The head lining ornamentation is the other interior finish, the scheme of which is to give the car an Arabesque effect, and the general air of elegance is heightened by the soft cushion like effect of the heavy rich velvet carpets.

CHANGES ON THE BURLINGTON.

Mr. G. W. Rhodes, for many years Superintendent of Motive Power of the Chicago, Burlington & Quincy, has been appointed Assistant General Superintendent of the Burlington & Missouri River, with headquarters at Omaha. Mr. F. A. Delano, Superintendent of Freight Terminals at Chicago, succeeds Mr. Rhodes as Superintendent of Motive Power. Mr H. J. Hetzler, Roadmaster at Chicago, succeeds Mr. Delano.

PERSONALS.

Mr. D. C. Courtney has resigned as Master Mechanic of the Middle Division of the Baltimore & Ohio at Cumberland, Md.

Mr. O. O. Winter has been appointed General Manager of the Brainerd & Northern Minnesota, vice Mr. E. H. Hoar.

Mr. Patrick Stack has been appointed Foreman of the Union Pacific shops at Laramie, Wyo.

Mr. E. Pennington, Superintendent of the Minneapolis, St. Paul & Sault Ste. Marie, has been appointed General Manager.

Douglas Stewart has been appointed Master Mechanic of the Rio Grande, Sierra Madre & Pacific, with office at El Paso, Tex., to succeed Mr. H. P. Olcott.

Mr. W. B. Bates has been appointed Master Mechanic of the shops of the St. Louis, Iron Mountain & Southern at Memphis, Tenn.

Mr. S. J. Dillon, heretofore Foreman of the erecting shops of the Pennsylvania at Jersey City, has been appointed General Foreman of passenger car repairs at that point.

Mr. Ethelbert E. Jenks has been appointed Foreman of the Atchison, Topeka & Santa Fe shops at Pueblo, Colo., vice Mr. H. E. Clucas.

Mr. A. F. Seltzer has been appointed Master Mechanic of the Michoacan & Pacific, with headquarters at Zitacuaro, Mex., in place of Mr. E. W. Knapp, resigned.

Mr. G. E. Mulfell has been appointed Master Mechanic of the Grand Trunk at Fort Gratiot, Mich., in plcae of Mr. R. Patterson, transferred.

Mr. A. E. Bouldridge has been appointed Master Mechanic of the Southern Railway at Louisville, Ky., vice Mr. J. B. Gannon. Mr. Bouldridge was General Foreman at Atlanta.

Mr. W. M. Paul has been appointed Master Mechanic of the Wabash shops at Tilton, Ill., to succeed Mr. G. J. De Vilbiss, transferred to Peru, Ind.

Mr. A. Carroll, of the Canadian Pacific, has been appointed Master Mechanic of the Crow's Nest Pass Line of the above system.

Mr. Benjamin Johnson, for several years in the employ of the Westinghouse Air Brake Company, has been appointed Master Mechanic of the Santa Fe shops at Topeka.

Mr. J. T. Stafford, heretofore General Foreman of locomotive repairs of the St. Louis, Iron Mountain & Southern at Baring Cross, Ark., has been appointed Assistant Master Mechanic of the road, with headquarters at that point.

Mr. P. J. Harrigan, General Foreman of the Baltimore & Ohio shops at Connellsville, Pa., has been appointed Master Mechanic of the Middle Division of that road, with headquarters at Cumberland, Md., vice Mr. D. C. Courtney, resigned.

William T. Moore, formerly for many years Master Mechanic of the Pitsburg Division of the Pennsylvania Railroad, died at his home in Sewickley, Pa., Dec. 1, at the age of 74 years.

Mr. J. R. Groves has been appointed Master Mechanic of the Kansas Midland Division of the Kansas City, Pittsburg & Gulf, with headquarters at Wichita, Kan., vice Mr. C. A. DeHaven, promoted.

Mr. J. E. Mulfeild, Master Mechanic of the Grand Trunk at St. Thomas, Ont., has received the appointment of Master Mechanic of the Western Division, with headquarters at Battle Creek, Mich.

Mr. R. Patterson, Master Mechanic of the Grand Trunk at Fort Gratiot, Mich., has been appointed Master Mechanic of the same road at Stratford, Ont., to succeed Mr. J. D. Barnett, resigned.

Mr. P. J. Milan, Master Mechanic of the Central of Georgia, at Augusta, Ga., has been transferred to Savannah, Ga., as Master Mechanic to succeed Mr. T. B. Irvin. Mr. Irvin goes to Augusta to take Mr. Milan's place.

E. F. Brooks has been appointed General Superintendent of the Philadelphia, Wilmington & Baltimore Railroad, vice Mr.. H. F. Kenney, resigned to accept executive duties in connection with lines in this company's system.

Mr. Charles A. Beach, formerly Superintendent of the Buffalo Division of the Lehigh Valley, has been appointed Superintendent of Terminals of the Central of New Jersey at Jersey City, N. J.

Mr. J. H. Goodyear, Chief Clerk to Mr. Tracy Lyon, Master Mechanic of the Chicago Great Western at St. Paul, Minn., has been appointed Assistant General Superintendent of the Buffalo & Susquehanna, to take effect Jan. 7.

Mr. T. H. Yorke, heretofore Foreman of the Chicago Great Western machine shops at South Park, Minn., has been appointed Division Master Mechanic of the Southwest Division of that road, with headquarters at Des Moines, Ia.

Mr. William Fitch, General Manager of the Duluth, South Shore & Atlantic, will succeed Mr. F. D. Underwood, who recently resigned to become General Manager of the Baltimore & Ohio.

Mr. David Van Alstine, Master Mechanic of the Louisville, Henderson & St. Louis, at Cloverport, Ky., has received the appointment of Assistant Master Mechanic of the Chicago Great Western, with headquarters at St. Paul, Minn.

Mr. Charles Treble, Round House Foreman of the "Big Four" at Wabash, Ind., has been appointed Superintendent of the locomotive and car department of the Dayton & Union, at Dayton, O.

Mr. R. R. Hammond, who has been Division Superintendent of the Kansas City, Fort Scott & Memphis, at Springfield, Mo., since July, 1895, has been appointed General Superintendent of that system, including the Kansas City, Memphis & Birmingham, with office at Kansas City, Mo.

Mr. V. A. Riton, at one time Superintendent of the Cascade Division of the Great Northern, and who recently went to the Norfolk & Western, has been appointed Superintendent of the Scioto Valley Division of that road, with headquarters at Kenova, W. Va., succeeding Mr. J. Robinson, resigned.

Mr. W. J. Fransioli has resigned as General Manager of the Manhattan Railway Company of New York, and will become identified with the Auto-Truck Company of New York. Mr. Skitt, who was recently the Manager of the lighterage system of the New York Central, and later elected Second Vice-President of the Manhattan Company, succeeds Mr. Fransioli as Manager.

Mr. J. D. Barnett has resigned as Master Mechanic of the Grand Trunk Railway, in whose service he has been since 1866, his occupancy of the office of Assistant Mechanical Superintendent and Master Mechanic at Stratford, Ont., dating from 1875. Mr. Barnett is one of the oldest members of the Master Mechanics' Association.

Mr. W. M. Greene has resigned as General Manager of the Baltimore & Ohio Southwestern. He will, however, continue as Vice-President and Director of the company, and will represent President Bacon and the interests of the Reorganization Committee and security holders, with headquarters at New York.

Mr. George W. Mudd, Master Mechanic of the Wabash at Springfield, Ill., has been appointed Master Mechanic at Moberly, Mo., in place of Mr. George S. McKee, who is transferred to Fort Wayne, Ind., to succeed Mr. C. H. Doebler, who has been transferred to Springfield. Mr. McKee will also have supervision of the Buffalo Division.

Mr. Mord Roberts, Master Mechanic of the Arkansas Division of the St. Louis, Iron Mountain & Southern at Little Rock, Ark., has had his jurisdiction extended over the Missouri Division, with headquarters at De Soto, Mo., on account of the resignation of Mr. W. H. Harris, heretofore Master Mechanic of the latter division.

Ranald T. McDonald, President of the Fort Wayne Electric Corporation of Fort Wayne, Ind., died of pneumonia in Dallas, Texas, Dec. 24, while on a business trip. Mr. McDonald was the founder of the electric manufacturing industry of Fort Wayne, and by his business ability, sagacity and great energy contributed very largely to the success of the organization of which he was President.

Mr. H. B. Gregg has been appointed Engineer of Tests of the Santa Fe Pacific in the office of Mr. G. W. Smith, Superintendent of Machinery. Mr. Gregg is a graduate in mechanical engineering, University of Wisconsin, and has had a number of years of experience in railroad signaling. He was also connected with the C. & N. W. Ry., and assisted in the Master Mechanics' Association investigation of exhaust pipes and smokestacks. After leaving that road he was engaged at the timber treating plant of the Atchison, at Bellemont, Arizona.

Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie, informs us of the following official changes in his department: Mr. W. Lavery, Assistant Superintendent of Motive Power, is transferred from the Ohio Division at Cleveland to the Erie Division at New York; Mr. George Donohue, Master Mechanic at Meadville, Pa., is appointed Assistant Superintendent of Motive Power, and succeeds Mr. Lavery at Cleveland; Mr. Willard Kells, Master Mechanic at Huntington, is transferred to Meadville, and Mr. John G. McLaren is appointed Master Mechanic at Huntington, the changes taking effect Feb. 1.

Mr. J. S. Turner, Superintendent of Motive Power of the Colorado & Southern Railway, announces the appointments of Mr. J. J. Cavenaugh, Division Master Mechanic at Denver, Mr. D. Leonard at Como and Mr. T. M. Gibbs at Trinidad.

Mr. T. W. Snow, whose long connection with the U. S. Wind Engine & Pump Company has given him a wide acquaintance with the needs of railroad water service, is now also in charge of the Chicago branch of the Otto Gas Engine Company, whose railway interests, and also those of the U. S. Wind Engine & Pump Company, will be jointly taken care of. No better choice could be made for these responsible duties, for the reason that Mr. Snow has devoted as much attention to water service details as any man in this country. His work in the direction of increasing the efficiency of water stations, for the purpose of reducing the time lost at tanks, has left its impress on many of the important lines, and established for him a well-earned reputation.

Mr. Clement F. Street, Member American Society of Mechanical Engineers, has resigned the position of Manager of the Railway and Engineering Review of Chicago to accept that of Manager of the Railway Department of the Dayton Malleable Iron Company at Dayton, O. Mr. Street was formerly chief draughtsman of the Motive Power Department of the Chicago, Milwaukee & St. Paul Railway, and has been connected with the "Railway and Engineering Review" for the past seven years, one year of which he devoted to a trip around the world in the interests of the Field Columbian Museum. Mr. Street has an exceedingly wide acquaintance and is very popular. He is a keen observer, and, being well informed on engineering subjects, he possesses qualifications which promise marked success in his new field.

Mr. Frederick D. Underwood has been called to the management of the Baltimore & Ohio system, with full jurisdiction over the traffic of the road. He was born in Wisconsin in 1849 and his experience has been gained in the West. He has risen through the grades of baggageman, conductor and superintendent on the Chicago, Milwaukee & St. Paul, reaching the position of General Manager of the Minneapolis & Pacific in 1886 and becoming General Manager of the lines forming the "Soo" system in 1888, directing the affairs of the latter road profitably up to the present time. This appointment is the outcome of new blood in the controlling factors of the Baltimore & Ohio property, among which are Mr. James J. Hill, President of the Great Northern, whose gifts as an organizer will assist to place the B. & O. among the prominent paying railroad properties.

W. Dewees Wood, one of the best known steel manufacturers of Pittsburgh, died at his home in that city January 2, at the age of 73 years, after a brief illness. Mr. Wood's family has been closely identified with the iron business of Pittsburgh, and at different times established several important iron manufacturing plants. Mr. Wood's greatest success was in the production of patent planished sheet iron, which now has a reputation for superiority all over the world, and has, in fact, almost entirely driven Russia iron out of the American market. The original works for this product were built in 1851, and have grown rapidly until they constitute one of the largest in their district, the annual capacity being 25,000 tons of planished and other grades of sheet iron per year; the works employ about 1,000 men, and over a million dollars is invested in the plant. The firm of W. Dewees Wood Company was incorporated in 1888, with Mr. Wood as President; Mr. Richard G. Wood, Vice-President and General Manager; Mr. Alan W. Wood, Secretary and Treasurer. During the past few years Mr. Wood has not been actively connected with the concern. This is the only firm of manufacturers of planished sheet iron in this country, and is a splendid memorial of its founder.

EQUIPMENT AND MANUFACTURING NOTES.

The Pintsch light was applied to 1,724 passenger cars during 1898, and the Safety Car Heating & Lighting Company also equipped 902 passenger cars with their steam heating system during the same time.

The J. A. Fay & Egan Company have sold their Chicago branch store to the firm of Manning, Maxwell & Moore of New York City, the sale dating from November 1st, 1898. The latter firm are now exclusive sales agents for Chicago territory for all the wood working machinery of both J. A. Fay & Co. and the Egan Company departments.

The Fox Solid Pressed Steel Company and the Schoen Pressed Steel Company have combined. It is believed that no radical change of manufacture is contemplated, and that the interests of the two concerns is merely consolidated.

The Wagner Company has closed a 25-year contract to operate its parlor and sleeping cars on the Fitchburg Railroad. New equipments will be built for this purpose.

The Union Pacific is remodeling a number of refrigerator cars using the Wickes system of refrigeration and ventilation, as a result of comparative tests extending over a number of years. The Northern Pacific made a similar change some time ago.

The Q & C Company has removed its offices from 100 Broadway, New York, to the corner of Liberty and Church streets, combining offices and salesrooms on the ground floor, where they will carry a stock of machinery and tools of their own manufacture.

Chicago rabbeted grain doors were included in the specifications for 2,000 box cars for the C., C., C. & St. L. Ry., 1,000 for the Chesapeake & Ohio recently contracted for with the Pullman Company, and for 500 box cars for the Denver & Rio Grande to be built by the Ohio Falls Car Company.

The Q. & C. Company now employs about 200 men in the works near Chicago. The plant is equipped for manufacturing a large variety of specialties, and now includes machines for stamping steel. Power is furnished by two engines, one of 200 and the other 150-horse-power, the boilers being fed by the Q. & C. Scott boiler feeder, illustrated in our issue of February, 1898, page 49.

The Long and Alstatter Company, Hamilton, O., are just completing the largest bloom shear ever constructed in this country. It is for the Loraine Steel Company, and will cut 100 square inches of metal at each stroke. Its total weight is 240,000 lbs., of which over 35,000 lbs. are steel castings, and the main shaft, which is of forged steel, weighs 10,000 lbs. A direct connected engine furnishes the power to drive it.

The Leach Locomotive Sander has made remarkable progress during the year 1898. We have received a statement, showing that it has been applied at the rate of about 182 sets per month, the total being 2,188 sets for the year. The automatic sander is now an absolute necessity, in order to secure the necessary adhesion of locomotives, with the tendency to increase cylinder power.

Passed Assistant Engineer Walter M. McFarland, who has been attached to the Bureau of Steam Engineering as assistant to the Engineer-in-Chief, leaves the naval service to enter that of the Westinghouse Electric and Manufacturing Company as Assistant General Manager. This is in line with the policy of the Westinghouse interests, to take the best engineering talent to be found.

The Westinghouse Electric and Manufacturing Company has the contract for changing the motive power of the Third Avenue Railway Company to electricity. From five to six million dollars are involved in this contract, which contemplates a power plant at 216th street, with a capacity of 64,000 horse-power, which will be in excess of anything thus far built.

The Chicago Grain Door Co. have just received the order for rabbeted grain doors for 700 Chicago Great Western box cars recently let to the Michigan Peninsular Car Co.

Mr. C. F. Quincy, President of the Q and C Company, has won a handsome cup bearing a striking likeness of himself, probably from a photograph, taken while playing golf. We do not mean that he won the cup by playing golf. He may be able to do so, but this cup is a token of esteem presented by his business associates and the local agents of the concern. It is a beautiful testimonial of the high regard in which he is held.

The lease of the Cambria Iron Company's works by the Cambria Steel Company has brought about the consolidation of the New York offices, formerly at 100 Broadway and 33 Wall street, at the new Empire Building, No. 71 Broadway, in rooms 1705 and 1706. Mr. H. L. Waterman is general sales agent for New York City and vicinity, and will give special attention to the sale of structural steel, steel blooms, billets and slabs. Mr. W. A. Washburne will handle negotiations for steel rails and railway track fastenings, and Mr. L. R. Pomeroy still gives attention to steel axles and other forging specialties.

Mr. H. J. Martinez, Member American Society of Mechanical Engineers, has been appointed Resident Agent at Havana, Cuba, for the Aultman & Taylor Machinery Co. of Mansfield, Ohio, manufacturers of the "Cahall" vertical and the "Cahall" horizontal water tube boilers. The business will be conducted under the name of Mr. H. J. Martinez, Consulting and Contracting Engineer. He will be prepared to submit estimates on the products of this company, the vertical type of boiler being claimed by them to be especially well adapted to the conditions and requirements of the sugar industry in Cuba and Porto Rico.

The passenger department of the Southern Pacific is taking the proper course to let the public know about their new fourteen-hour train between San Francisco and Los Angeles. This train, known as the "Owl," comprises, at this time, the regular equipment of the road, made up of a day coach, composite car, two high-class wide-vestibule Pullman drawing room sleeping cars, and a dining car. Travel between these two cities having lost its intermittent character, this train has been put on to meet the demands of rapid growth. New equipment is now being constructed for the "Owl," which will be a solid, wide-vestibuled train from end to end, with every modern elegance and convenience.

The Babcock & Wilcox Company have taken from Westinghouse, Church, Kerr & Company the largest stationary boiler order that has ever been placed. The boilers are for the power plant which the Westinghouse Electric Company have contracted to build for the Third Avenue Railroad Company at 218th street and Harlem River, New York, and which is to be constructed by Westinghouse, Church, Kerr & Company. The order covers sixty Babcock & Wilcox forged steel boilers of 520 horse-power each, or an aggregate of 31,200 horse-power. The boilers are to be capable of carrying 200 lbs. steam pressure. They will supply steam for compound condensing engines of 64,000 nominal horse-power in the aggegate. Added to large steaming capacity the Babcock & Wilcox boilers have a record for extremely low cost of maintenance.

The Duff Manufacturing Company of Allegheny, Pa., have issued a pamphlet in which the Barrett patent compound lever jack is described as combining all the qualities recommended by the Committee on Track Jacks, appointed by the Roadmasters' Association in convention in Indianapolis. Twenty different styles of jacks are shown in the pamphlet, for every conceivable requirement. The Barrett jacks are guaranteed to be positive and quick in action, and they are simple and easy in movement. The materials used in construction are of the strongest and best. In a list of railroads using these jacks we count 134 of the best, most important and most successful roads in the United States.

The Long Island Railroad is rapidly transforming its locomotives into anthracite burners, in compliance with the demands of the New York Board of Health for elimination of the smoke nuisance. Nine new anthracite burners have been ordered, 19 engines are undergoing the necessary alterations to burn the smokeless fuel, and 16 engines are already using anthracite coal.

The New York Central is to erect a new building for the Young Men's Christian Association, at a cost of about $20,000. It will be 40 by 99 feet, and located at Seventy-second street freight yards, New York City, to take the place of the quarters which they have outgrown.

The McCord journal box and lid is being applied to 50 cars for the Brainard & Northern Minnesota, 500 flat cars for the Northern Pacific at the Barney & Smith Car Co., 1,450 cars for the Delaware & Hudson, 700 box cars for the Chicago Great Western at the Michigan Peninsular, and 200 cars for the Chicago & West Michigan.

The Bangor and Aroostook has ordered three locomotives from the Manchester Locomotive Works.

The Fitchburg Railroad is having ten locomotives built, two by the Manchester Locomotive Works and eight by the Schenectady Locomotive Works.

In the year just passed the Baldwin Locomotive Works completed 760 locomotives, representing every service in which a locomotive is used. Much of the output was shipped to foreign countries, the larger part going to Japan and Russia. This record does not, however, reach that of 1891, when 946 engines were built, which very nearly reached the estimated capacity of the works. The present year opened with orders for 200 engines, and they are still coming in. These orders are mostly for rapid delivery, and the works are running day and night in consequence.

The Chicago Great Western has ordered ten 10-wheel engines from the Baldwin Locomotive Works. The order is for March delivery, and is equally divided between simple and compounds, the former to be 20 by 28 inches and the latter of the Vauclain type, 16 by 26 by 28 inches stroke. The driving wheels are 63 inches diameter and will have an adhesive weight of 123,000 pounds, and the weight of the engine in working order is to be 163,000 pounds. The fireboxes will be above the frames, with a width of 42 inches and length of 112 inches. The tenders are large capacity, holding 6,000 gallons of water and 10 tons of coal.

The Rogers Locomotive Works have a contract with the Great Northern for 35 engines, 25 of which will be 12-wheel, for freight, and ten 10-wheel for passenger service. The latter engines will have cylinders 18 by 26 inches, cast steel driving wheels 73 inches diameter, with 97,000 pounds adhesive weight, and a total weight of 197,000 pounds. The boilers are to be of the Belpaire type, designed for a pressure of 210 pounds. Capacity of tender for water, 4,500 gallons. The freight engines are to be 19 by 32, with 55-inch drivers of cast steel. The adhesive and total weights of these freight engines will be 152,000 and 182,000 pounds respectively. The boilers will be Belpaire, with extended wagon tops, and also designed for 210 pounds pressure. Capacity of tender for water, 5,000 gallons.

The Erie has ordered four compound engines of the Atlantic type from the Baldwin Locomotive Works. The chief characteristics are as follows: Weight on drivers, 82,000 pounds; total weight, 142,000 pounds; cylinders, 13 and 22 by 26 inches; drivers, 76 inches diameter; Wootten boilers designed for 200 pounds pressure; fire boxes, 96 by 96 inches; tender, 6,000 gallons of water and 20,000 pounds coal. Orders have also been given for twenty simple 10-wheelers, fifteen of which will be built at the Richmond Locomotive Works and five at the Rogers Locomotive Works. Weight, 144,000 pounds, with 105 pounds on drivers; cylinders, 20 by 26 inches; drivers, 63 inches diameter, and boiler pressure 180 pounds; fire box, 40½ inches wide and 107⅛ inches long. Water capacity of tender, 6,000 gallons; coal capacity, 20,000 pounds.

Since the publication of our article on short smoke boxes for locomotives, on page 391 of our December issue, 1898, we have received several communications on the subject, among which is one stating that the Brooks Locomotive Works are putting on Mr. J. Snowden Bell's arrangement whenever they can do so, and that they consider it the best form to use. It is being applied to three consolidation engines with wide fire-boxes, 72-inch boilers and 21 by 26 inch cylinders for the Long Island Railroad and on large 10-wheel passenger engines for the Buffalo, Rochester & Pittsburg and others. These fronts have been appplied to more than 100 heavy locomotives built at these works, which is a good indication of progress in front end reform.

In accordance with the plans formulated two years ago by the receivers to place the Baltimore & Ohio Railroad in first-class physical condition, considerable work is being done on the Trans-Ohio divisions. The improvements are being made with a view to using 70-ton locomotives on all portions of the line, and since July 9, 290 tons of 75-pound and 12,943 tons of 85-pound steel rails have been laid on the Central Ohio, Lake Erie and Chicago divisions. About 17 miles of new side tracks have been constructed, five telegraph towers erected, a new freight depot built at Mansfield, Ohio, an interlocking plant installed at Plymouth, Ohio, and five water stations, to expedite freight traffic, constructed. Further improvements of a more extensive character are being planned, in order to materially increase the train haul.

The Pennsylvania Car Wheel Company, of Pittsburgh, young as it is, has made such strides forward that it has found it necessary to add a new area of 10,000 square feet to its shops. This company has just passed its first year of organization, having been incorporated Jan. 4, 1898, and in April next it will have passed its first year of production. Though new as the Pennsylvania Car Wheel Company, the members of the corporation are by no means new in the business, Mr. C. V. Slocum, secretary and treasurer, having been identified for years with the New York Car Wheel Company, at Buffalo. The company points with proper satisfaction to the fact that its wheels have passed the exacting P. R. R. tests, made before the representatives of Mr. F. D. Casanave, Superintendent of Motive Power at Altoona, as well as those of the Schoen Pressed Steel Cimpany, both of which are users of the Pennsylvania wheels.

Six new sleeping cars are being built at the Wagner Palace Car Company's shops at East Buffalo for use in Wagner service. The remarkable feature of these new cars consists of a greater length than heretofore used in sleeping cars, the bodies to be 74 feet in length, as against 70 feet for the longest of these cars they have built. There are some private cars that may exceed these in length, but they will be longest sleepers ever built. One advantage in the increased length of these cars will be a greater length of berth than can be had in the ordinary sleeper, and the improvement will be one giving a passenger a greater sense of freedom than is now enjoyed in the smaller ones.

The capacity of the plant of the Westinghouse Electric and Manufacturing Company at East Pittsburgh is to be doubled, the contracts for the extensions having recently been closed, which will make these works the largest in this country, if not in the world. The new buildings will add about four acres to the floor space. The machine shop as it stands is 750 feet long; this will be increased to 1,000 feet. A building six stories high will be devoted to the uses of the officers, engineers, draftsmen and clerks. The extension to the machine shop of the Westinghouse Machine Company will be architecturally the same as the old shop which it is to join, with walls of brick and frame of steel. The largest contract ever received by this concern closed a few weeks since, and said to be the largest ever awarded to any firm of engine builders, was that from the Brooklyn Light and Power Company, for an installation in its power house now in course of construction, of 18 engines, with units of 5,000 horse power. The engines for the Metropolitan Construction Company of London are now completed at these works.

The business of the Chicago Pneumatic Tool Company for the year just closed may be inferred to be good when it is understood that the rate of increase was so rapid that the volume of trade for the last month of 1898 was four times that of the same month of the preceding year. The causes for this flattering business situation are to be found not so much in the new openings for compressed air as in extension of the use of the ingenious pneumatic tools built by this company. The United States Government has recently shown its appreciation of their labor-saving devices by awarding contracts for the equipment of the navy yards with them. The foreign trade is reported to be keeping pace with the growing demand for their specialties in this country, the tools having been adopted by prominent shipbuilders on the Clyde and in important manufacturing establishments in England and on the Continent. The increased use of these pneumatic tools is explained by the wide range of work they are designed to cover, embracing, as they do, almost everything in the manufacturing line from railroad shops to navy yards.

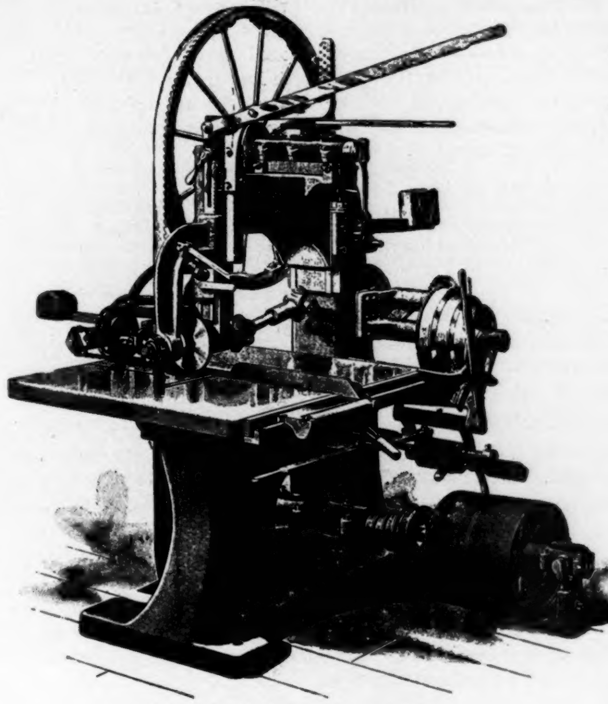
Gas engines having come very much into vogue as the best driver for pumping stations for railroads, the F. M. Watkins Company of Cincinnati are urging their "Sumner" engines as particularly well adapted for such use. The "Sumner" engine is said to be the outgrowth of fifteen years' experience, and many installations are to be seen where the requirements are the same as in railroad pumping station work. The great advantages of gas engines for pumping station work are obvious. The expense of keeping up steam continuously, whether power is needed or not, is wholly eliminated, as well as the cost and annoyance of handling coal and ashes. Then, too, no engineer is required to operate a gas engine, little instruction being needed to make any one competent to operate one. The gas engine furnishes a motive power ever at command, easy to start or instantly stop, safer from danger of fire than steam, and very much more economical. Moreover, there is no expense while the power is not being used. The Watkins Company ask a hearing with parties interested, and the class of present customers named by them is an indorsement of their claims.

It was reported that Pintsch gas exploded and caused a fire that destroyed four cars of a wreck of an Atchison limited train near Trinidad, Col., December 28, but after thorough investigation the officers of the road say that the gas-lighting equipment had nothing whatever to do with the fire. Such accusations have been made before, and, as far as we know, with the same result. Wide experience with this apparatus shows that it does not explode, even when the cars are destroyed by fire. The gas tanks may become heated, but before a dangerous pressure can be produced the rubber gaskets or the soldered joints will give way and provide escape for the gas; and, we are told, it burns quietly. A mixture of air and gas with a large proportion of air is necessary to produce an explosion, and it is difficult to comprehend how such a condition can occur. The smell of gas is noticeable when only a fraction of 1 per cent. is present in the air, and that this is sufficient to scare people at a wreck who are already excited and lead them to believe themselves to be on the verge of a horrible explosion is the only explanation we can think of to account for the tendency to charge fires against Pintsch gas. There are 85,000 cars using this system of lighting, and we believe the record for safety to be perfect.

A NEW AUTOMATIC BAND RIP SAW.

Our illustration of the automatic band rip saw shows one of the latest productions of The Egan Company, of Cincinnati, O. The machine takes in 24 inches between the saw and the adjustable fence, and 10 inches under the guide. It has three feed speeds, in and out feeding rolls, and an improved straining device which controls the upper wheel and the path of the saw blade on the face of the wheels. This device has an adjustment in every direction in a horizontal plane, and is of the most sensitive character, taking up the slack in the blade in-

stantly under all service conditions. The wheels carrying the saw blade are 42 inches in diameter, of iron and steel, the upper one having spokes, and the lower one a solid web, the object of which is to prevent the stirring up and circulation of dust at the floor. There are powerful feeds of 60, 90 and 130 feet per



A New Automatic Band Rip Saw.

minute, but faster feeds are furnished when desired. The advantage of the in-and-out feeding rolls lies in the fact that very short stock may be worked up with facility; these rolls are capable of instant adjustment, up or down. The machine is furnished with a blade of 2½ inches by 20 feet, although blades up to 3 inches wide may be used. This machine is the latest result of expert effort in tool improvement by the Egan Company.

BOOKS AND PAMPHLETS.

Proceedings of the Sixth Annual Convention of the Traveling Engineers Association, held at Buffalo, N. Y., September, 1898. Edited by W. O. Thompson, Secretary, Elkhart, Indiana, 1898. 217 pages (standard size, 6 by 9 inches).

This pamphlet contains a complete report of the 1898 convention, the committee reports and discusions, a list of members and the constitution and by-laws. The object of the association, as stated in the constitution, is to "improve the locomotive engine service of American railroads." This is admirably supported in the present volume, which is full of practical thoughts concerning methods of improving the handling of locomotives with economy and efficiency. It is a volume that may be read with profit by the higher mechanical officers. The report is well edited, and it shows the careful work of the secretary, which is particularly apparent in the index. The attention given the index is well worth while, and it will be appreciated by those who have occasion to refer to the opinions expressed in the reports.

Cuba: Its Resources and Opportunities. By Pulaski F. Hyatt, United States Consul, Santiago, Cuba, and John T. Hyatt, United States Vice-Consul, Santiago; 211 pages; illustrated. New York, 1898, J. S. Ogilvie Publishing Co., 57 Rose street. Price, $1.50.

The authors of this book, having spent nearly six years in Cuba in the United States Consular Service, enjoyed exceptional opportunities for observation concerning the natural resources of the island, and they were naturally called upon to give information to many who desired to learn about business opportunities there. The demand for information became so great as to necessitate putting their knowledge and experience into the form of a book. A large portion of the space is devoted to the natural resources of the island, and important suggestions are made as to methods of utilizing the present facilities for transportation. The political and geographical conditions and the character of the people, the labor, commercial and climatic conditions are also treated. Not the least valuable chapter is one giving a business directory of the island, with the names and addresses of tradesmen located in each of the provinces. The book will be valuable to those who are seeking to form trade relations with Cuba.

The Story of the Railroad. By Cy Warman. Published by D. Appleton & Company, New York. Illustrated by B. West Clinedinst. 1898. Price $1.50.

This is an intensely interesting account of the inception and early history of the railroads crossing the Western plains and mountains to the Pacific coast. It presents not only the story of the Western railroad, but tells us the character of those most courageous and devoted men, the locating engineers, who suffered and sacrificed more than any writer can tell. The story exhibits the life that grew out of the peculiar roughness of the new country, and the constant danger to person and property. It is full of anecdote and accounts of times that were stirring, when it was necessary to "flag with firearms" and when every new city began with a graveyard. The discouragements of the promoters, the hardships, privation and often death of the "pathfinders," the difficulties of construction and the early problems in operation are all told in an interesting, entertaining way. The book gives such a broad and correct view of the development of the Western country, and the influence of the railroad upon it, that everyone should read it for the sake of knowing how all this was done. We find great satisfaction in Mr. Warman's memorial to the locating engineer. All the way from the Atlantic to the Pacific he has been forced to fight, leaving along his new-made trail heaps of bleaching bones that tell of his trials, and marvellous feats of engineering that speak of his skill. Mr. Warman has written an interesting and inspiring book, that is not disappointing in any way.

Fowler's Mechanical Engineer Pocket Book. By Wm. H. Fowler, editor of "The Mechanical Engineer"; 324 3¾x6-inch pages, with 22 illustrations. The Scientific Publishing Company, Manchester, England. Price one shilling sixpence.

To properly review a pocket book for engineers it is necessary to use it, but we can say that this volume is a surprise in the amount of matter put into such a small volume. It costs only about 35 cents in our money, and this is accounted for by a large number of advertisements which it includes. The book is divided into sections, and each of these was intrusted to an engineer who had made specialties of its subjects. Steam boilers, transmission of power, general notes, tables and arrangement are by the editior, who is an authority on boiler work. Other subjects are treated by men as well qualified to handle them. We note one on locomotives by C. E. Wolf, of the staff of the Midland Ry. The book is not a treatise on any subject, and the formulas are not worked out, it being taken for granted that they are correct. A large amount of information is presented. It appears to be well planned, well considered, well edited and it has a good index.

A graduates' magazine—"The Technology Review"—has just been issued by the recently organized Association of Class Secretaries of the Massachusetts Institute of Technology. It is an octavo volume of 140 pages, attractive in appearance and of the best workmanship. The cover, designed by Hapgood and printed on Army brown paper, is very handsome. The first number contains the announcement; a photograph, with biographical sketch, of President Crafts; articles on "The Function of the Laboratory," by Professor Silas W. Holman, and on the "Pierce Building," by Professor Eleazer B. Homer, the architect; also reprints, in fac-simile, of early institute documents and letters. The latter half, seventy pages, is given to news of the Institute of the undergraduate and graduate classes. Plans are shown of the several floors of the new Pierce Building, of the first floor of the Rogers Building, as now altered, and of the dynamo house. There are two half-tone inserts and two line-drawings, one by Gelett Burgess. An excellent review of Professor Holman's recent book on "Matter, Energy, Force and Work," is given by Dr. Goodwin. This is one of the most interesting of the "Tech." periodicals we have seen, and is creditable from every point of view.

Repairs of Railway Car Equipment, with Prices of Labor and Material. A Reference Book for Railway Officials, with Average Shop Cost of Repairs to Passenger and Freight Cars. By H. M. Perry, 172 pages, cloth. Published by the Railway Age, Chicago, 1899. Price, $2.00.

Mr. Perry has had 30 years' experience in railroad car work, and presents the information in regard to cost of car building and repairs that he has found desirable to have in connection with his work. The book contains detail bills of materials for cars, trucks, platforms, roofs, doors, etc., and tables of the weights of iron and other material, also tables of board measure and weights, and sizes of bolts, nuts, washers and other minor details. The prices for both labor and material for freight cars are based, as far as possible, on the prices in the code of rules of the Master Car Builders' Association, governing the repairs to cars and from these damaged car reports will be correct, under the present rules, for all sections of the country. It is apparent that if the rules change, the plan is somewhat upset, but this may be provided for in future editions of the work. The compilation of this information required a large amount of work, and the minuteness of details is its greatest recommendation. The tables are divided into small units, and the prices and weights of parts are grouped for convenience in taking off the costs of the units as well as the totals, and in general the book is admirably arranged. The costs of special equipment, such as vestibules, couplers, air brake and Pintsch light, are given in groups and in detail, and the criticism applied to these is equally applicable to all the prices, namely, they are subject to change, and it would be well, unless a new edition appears every year to provide blank columns for changes in the prices. The tables of useful information in the closing pages include a great deal of matter that has appeared in other publications, but it will be found convenient to be able to turn to it in connection with the items concerning cars. We believe that every officer having to do with cars, and especially those who handle bills for repairs, will need and will appreciate the book. It has great value aside from the prices. We do not know where else to find so much information on the subject of weights of parts. The book is well printed and bound, and is a credit to the publishers.

Railway Economics. By H. T. Newcomb, LL.M., Chief of the Section of Freight Rates in the Division of the Statistics of the United States Department of Agriculture, and Instructor in Statistics and Transportation in Columbian University. Philadelphia: Railway Publishing Company, 1898.

This has appeared in serial form in the "Railway World," and at the request of the railway officials it was compiled in book form. The subjects include transportation, capitalization, income and expenditure, the decline of charges, rates and prices, causes of the decline of charges, competition, the law of increasing returns, unjust discrimination, long and short haul charges, pooling associations, taxation and construction. Many statistics are presented, and the position and experience of the author is a guarantee that they are correct. The chief object of the book is to show the position of the railroad in the present organization of industry in the United States. It is a concise statement of the author's ideas of the necessities of the present situation.

Indicator Diagrams and Engine and Boiler Testing. By Charles Day, M. I. M. E. Second edition, 212 pages. Illustrated. The Technical Publishing Company, Ltd., 31 Whitworth Street, Manchester, England. D. Van Nostrand Company, 23 Murray Street, New York. Price four shillings sixpence.

This book has two prime objects. First, to explain the construction and use of the indicator; and, second, to discuss the testing of engines and boilers. The part devoted to the indicator gives a great deal of attention to defective indicator diagrams, and uses them as instances of the modes of reasoning applicable to indicator diagrams generally. These diagrams are instructive and interesting, also as a study of valve action. The part devoted to boiler testing includes a very complete table of piston constants, compiled by Mr. W. H. Fowler. It also includes discussion of coal and gas analysis. The fact that the book has run through its first edition so soon is evidence of its popularity.

Commercial Relations of the United States, 1896 and 1897. Vol. II., Europe. Department of State, Washington, D.C., 1898.

This is the companion volume to that noticed in these columns in our December, 1898, issue. It is issued by the Bureau of Foreign Commerce of the State Department, and contains statements with regard to the commerce of the United States with all of the European countries.

The Customs Tariff of Japan. In effect Jan. 1, 1899. Published by the Japan-American Commercial and Industrial Association, Times Building, New York. Paper, 44 pages.

This pamphlet contains the tariff laws of Japan and tables of the specific and ad valorem duties on articles imported into the country, also the conventional tariff between Japan and Great Britain and the principal European countries. It is a valuable publication for those who are engaged in trade with Japan. Copies may be had from the association at the address given above.

Proceedings of the Twenty-ninth Annual Convention of the Master Car and Locomotive Painters' Association of the United States and Canada, held at St. Paul, Minn., September, 1898. Published for the association by the Railroad Car Journal, New York. Standard size, 117 pages, illustrated.

This volume contains the name and addresses of the members of the association, the constitution and by-laws and the proceedings of the 1898 convention, including the reports and the discussions. This is a record of the progress of car and locomotive painting, and that of the opinions of the men who are best informed.

The Railroad Officials' Diary, published by the Railroad Car Journal, 132 Nassau street, New York. Price, $1.00.

This book is standard size, 6 by 9 inches, and has a blank page of good quality of white paper for every day in the year. It is bound handsomely in flexible leather, and is very convenient for records or appointments. It contains a list of the railroad technical organizations, their officers and dates of meetings, and also railroad statistics from the report of the Interstate Commerce Commission, arranged in convenient form, and a list of leased railroads.

The Lehigh University, Origins and Destiny. An address delivered on Founders' Day, Oct. 13, 1898, by Langdon C. Stewardson, Chaplain of the University. Paper, 26 pages. Published by the University, South Bethlehem, Pa., 1898.

Bulletins of the United States Geological Survey, Nos. 151 to 156 inclusive. Department of the Interior, Government Printing Office, Washington, 1898.

Transactions of the American Society of Mechanical Engineers, Vol. XIX., 1898. Published by the society, New York, 1898.

This volume contains the usual list of officers, the rules of the society, the papers and discussions of the 36th and 37th meetings. It is printed in the usual satisfactory style, and is accompanied by an excellent index.

Cassier's Magazine for January contains an admirable article on the arrangement of railroad shops by Mr. William Forsyth, Superintendent of Motive Power of the Northern Pacific Railway. The author presents plans of 13 representative shop plants and discusses the principles involved in the ideas of the designers. It is the best general article on the subject that we have seen.

Valentine & Company, the well known varnish manufacturers, have issued a very attractive pamphlet of their numerous awards at the expositions where their goods have been displayed. The reproductions of the engrossed work are in the form of beautiful half-tones, and the medals are reproduced in bronze, which gives a very clear idea of the originals. The catalogue is a work of art and worthy of preservation even by those who are not interested in a commercial way in the industry that is able to present such interesting evidences of appreciated merit.